NORTH · AMERICAN · AVIATION · INC

INGLEWOOD · CALIFORNIA

SERVICE

SCHOOL LECTURES

B-25 DAILY PREFLIGHT

[illegible]

BEFORE ENGINE START

1. Examine Flight Reports for Squawks.

2. Perform any Routine Inspections that might be due.

3. Remove Engine and Turret Covers; stow in Ship.

4. Drain and Resafety Weatherheads, [illegible]

5. Remove Lower Engine Cowl, check Oil Drain, Safety and usual inspection of Lines and Engine Accessories.

6. Open Main Gear Nacelle Doors and inspect condition of Struts and Strut Level (2-7/8 inches). Check for Hydraulic leaks and general condition of Hydraulic Lines. Check Battery Installation (secure).

7. Open Nose Gear Strut Nacelle and inspect condition of Strut and Strut Level (5-3/16 inches). Check for Hydraulic leaks and general condition of Hydraulic Lines.

8. Exhaust Accumulator for proper Hydraulic Fluid Check.

9. Check Oil Stick, R-H and L-H Engine.

10. Check Fuel by Gauge and Cap Level.

11. Check Fuel Caps for proper installation.

12. Remove Top Cowl and check Engine Controls, Fuel and Oil Lines.

13. Check Flight Controls for free movement and alignment of Trim Tabs and Wing Flaps.

14. Check Anti-Icer Fluid.

15. Check all Instruments for broken, loose or dirty Cover Glasses and proper Pointer Position.

INSTRUCTOR'S SIGN OFF

Class 1. B. Woods Instructor

Class 2. ______________________ Instructor

Class 3. ______________________ Instructor

ENGINE START

1. Head Airplane into the wind.
2. Place Chocks in front of Wheels.
3. Check Ignition Switches off.
4. Pull Props through 3 Full Revolutions.
5. Main Gear Nacelle Doors up.
6. Loose Cowling clear of Ship.
7. Check Emergency Fuel Shut off Valves on.
8. Inverters on.
9. Generator Switches on.
10. Heater off.
11. Hydraulic Selector Valve normal.
12. Brake Pressure minimum 600 lbs.
13. Set Park Brakes,
14. Cowl Flaps open,
15. Hydraulic Operated Controls in Neutral Position (except Landing Gear).
16. Oil Cooler Shutters Closed (cold Engine).
17. Superchargers "Low" and Locked.
18. Carburetor Air Normal.
19. Automatic Pilot Locked in "Off".
20. Mixture Control Full Rich.
21. Propeller Full Increase RPM (Low Pitch).
22. Throttles open 1/2 inch (800) RPM.
23. Fuel Booster Pumps Both on.
24. Check all those Electrical Switches not mentioned, Off. Radio, Anti-Icer Etc.
25. Emergency Escape Hatches Unlocked.
26. Battery Disconnect Switches Both on.
27. Check Fuel Booster Pressure - 2.5 to 4 lbs.
28. Check Fuel Level.

29. Determine that no one is near Props (clear).

30. Master and Magneto Switches on, turn Mag. switch on for individual Engine.

31. Prime approx. 7 shots, (cold Engine) one second duration, while Energizing.

32. Note Left and Right Engine Toggle Switches.

33. Energize 30 seconds minimum.

34. Engage, holding Energizer Switch on.

35. As Engine starts, disengage Switches, and check Oil Pressure. If not 40 lbs. in 30 seconds, stop Engine and investigate.

36. Warm Engine at 1200 RPM.

37. Turn Fuel Booster Pumps off and note Drop.

38. Check general Hydraulic and Brake Pressure.

39. When Oil Temp. indicates 55 degrees C., and Cylinder Head Temp. indicates 150 degrees C., check Engines individually.

ENGINE RUN-UP

1. When Engines have reached Run-Up temperatures, check Engines individually.
2. Keep Engine not being checked at approx. 1000 RPM min.
3. Run Engine slowly to 1700 RPM, noting Engine performance.
4. Check all Instrument Mounts for excessive vibration and Instruments for excessive Oscillation.
5. Check Propeller Governor at 1700 RPM.
6. Engage High Blower at 1700 RPM. Return to Low Blower at 30 inches M.P.
7. Check Engine Idle for 550 - 600 RPM.
8. Check Engine for Full Power, 2600 RPM at 44 inches M.P.
9. Check Magnetos at 2000 RPM -- Maximum allowable drop, 75 RPM.
10. Check Fuel Pressure 6-7 lbs. at 2000 RPM.
11. Check Oil Pressure 80 - 90 lbs. at 2000 RPM.
12. Check Suction 3.75 - 4.25 at 1000 RPM.
13. Check De-Icers for proper movement.
14. Check Hydraulic Pressure 800 - 1100 lbs.
15. Check Brake Pressure 1000 - 1200 lbs.
16. Check Wing Flap movement of Indicator.
17. Check Cowl Flap movement.
18. Check position of Landing Gear Indicators.
19. Check Volts, 28 to 28.5 at 1600 RPM and Amps., 40 to 60 max.
20. Shut Engines off at 1500 RPM, with max. Head Temperature 190° C.

AFTER ENGINE CHECK

1. Remove Lower Engine Accessory Cowl (R-H and L-H Engines) for usual inspection.
2. Check Engine for Rocker Box leaks.
3. Check Propellers for usual Oil Leaks.
4. Install all Cowling and check all Dzus Fastenings.
5. Close and safety Nacelle Doors.
6. Check Fuel and Oil.
7. Check Fuel Cap installation.
8. Check Tires; 44 lbs. Main Gear Tires, 45 lbs. Nose Gear Tire.
9. Check emergency Air Brake Pressure 550 to 600 lbs.
10. Check Fore and Aft Accumulators 425 lbs.
11. Check Nose Wheel Lock Pin.
12. Check Nose Gear Shimmy Damper Indicator - 3/8 inches.
13. Hand Starter installed.
14. All ship Fire Extinguisher s installed.
15. All ship cushions installed.
16. Clean Struts.
17. Clean Windows.
18. Clean Cockpit.
19. Clean external surface of Ship.
20. Check Form 1.
21. Check Squawk Sheet.
22. When Pre-Flight complete, close all Hatches and stand by for flight.
23. Ascertain that all Auxiliary Equipment, such as Communications, Gunnery, Bombing and Photography Equipment have been given all required inspections and maintenance by specialists charged with this work; and that W.D., A.C. Form No. 1A has been filled out and shows the exact status of the Airplane.

AFTER ENGINE CHECK (Continued)

24. Assist the pilot in storing any luggage and assist the pilot in attaining a more thorough knowledge concerning the location, operation and functioning of Engine Controls, Flight Controls etc., when requested to do so.

25. See that Cover has been removed from Pitot Static Head.

26. Pull Airplane Wheel Chocks when signaled to do so by Pilot.

OPERATION NOTES - B-25

STARTING

WATCH OVER PRIMING PRIME SHOTS LAST APPROX. 1 SECOND AT 3 SECOND INTERVALS. ENGINE MUST HAVE NORMAL OR SLIGHTLY MORE PRIME FOR EFFECTIVE STARTING.
COWL FLAPS SHOULD ALWAYS BE IN OPEN POSITION ON STARTING, AS EXHAUST THROWS RAW GAS AND FIRE OUT COLLECTOR RING MAKING A DEFINITE FIRE HAZARD.
THROTTLE POSITION SHOULD BE APPROX. 1/2 INCH OPEN. (650 - 800 RPM)
NEVER AGITATE THROTTLE
WARM ENGINES AT 1000 TO 1200 RPM.
NEVER IDLE MORE THAN NECESSARY, AS PLUGS WILL FOUL INCREASING MAG. DROP.
CHECK MANUAL PROP. GOV. AT 1600 RPM.
ENGAGE HIGH BLOWER AT 1700 RPM ON ENGAGING HIGH BLOWER ENGAGEMENT SHOULD BE MADE AS RAPID AS POSSIBLE, TO DECREASE CLUTCH SLIPPAGE. AS SOON AS M.P. HAS STOPPED FLUCTUATING RUN ENGINE TO 30 INCHES M.P. THEN AS SOON AS M.P. STOPS FLUCTUATING, RAPIDLY RETURN TO LOW BLOWER. IF M.P. DOES NOT FLUCTUATE ON THESE ENGAGEMENTS, CLUTCH IS SLIPPING AND NOT WORKING PROPERLY.
CHECK MAG. DROP AT 2000 RPM. MAX. MAG. DROP IS 75 RPM. IF MAG. DROP IS MORE THAN THIS, PLUGS ARE USUALLY FOULED. THIS PROCEDURE CAN SOMETIMES BE USED TO CLEAN PLUGS: RUN ENGINE TO 1700 RPM AND PLACE MIXTURE CONTROL IN CRUISING LEAN POSITION. RUN ENGINE FOR THREE MINUTES REPLACE MIXTURE CONTROL TO FULL RICH POSITION AND RECHECK MAGS.

SHUTTING ENGINE OFF IS DONE PROPERLY BY RUNNING ENGINE TO 1500 RPM FOR 2 OR 3 MIN. PLACE MIXTURE CONTROL IN IDLE CUT-OFF AND AS RPM BEGINS TO DROP, OPEN THROTTLE QUICKLY AND HOLD UNTIL ENGINE STOPS ROTATING. TURN MAG. SWITCHES OFF AND BATTERY DISCONNECT SWITCHES OFF.

PECULIARITIES

ON STARTING IF ENGINE BACKFIRES, AND A RETARD PRESSURE IS FELT IN THE THROTTLE, IT IS USUALLY A SIGN THAT THE THROTTLE IS TOO FAR ADVANCED. CLOSE THROTTLE IMMEDIATELY AND SLOWLY ADVANCE THROTTLE UNTIL ENGINE PICKS UP. IF ENGINE STACK REPEATEDLY BANGS WITH OUT ENGINE STARTING IT IS USUALLY A SIGN THAT THE ENGINE IS UNDER PRIMED, OR MIXTURE IS IN IDLE CUT OFF, OR FUEL IS NOT TURNED ON, OR BOOSTER PUMPS ARE NOT ON, OR SWITCHES ARE OFF.

SUCTION

THE SUCTION IS SET AT AVERAGE 4.00 ON THE GROUND. READING WILL DROP IN THE AIR, SO IT IS SUGGESTED THAT THE SUCTION BE ADJUSTED TO MAXIMUM OF 4.25.

WARNING HORNS

WARNING HORNS ARE SET AT 15 INCHES M.P. AT 5000 FEET ALTITUDE. ACTUAL SETTING CAN ONLY BE MADE IN THE AIR, BUT ADJUSTMENT CAN BE MADE ON THE GROUND.

FLAPS AND TRIM TABS

FLAPS AND TRIM TABS SHOULD BE CHECKED FOR EVEN PLANE WITH CONTROLS LOCKED IN NEUTRAL. CHECK WING FLAPS TO SEE IF ALL ARE ON THE SAME PLANE. ALSO NOTICE INSTRUMENT READING WHEN THE FLAPS ARE IN THE UP POSITION.

LANDING GEAR INSTRUMENT

WITH BATTERY DISCONNECT SWITCH ON, CHECK POSITION OF WARNING FLAGS. IF FLAGS SHOWING WITH GEAR DOWN, ASCERTAIN THAT GEAR LOCK PINS ARE IN PLACE. IF O.K. ADJUST INSTRUMENT SO THAT FLAGS COMPLETELY DISAPPEAR.

RATE OF CLIMB

NOTICE THAT RATE OF CLIMB INDICATOR IS ON ZERO. IF NOT, TURN ADJUSTING SCREW AND AT THE SAME TIME TAP GLASS UNTIL INDICATOR POINTS TO ZERO.

AIR SPEED

CHECK PITOT TUBE FOR FREEDOM OF OBSTRUCTIONS, AND USING SLIGHT PRESSURE NOTICE EFFECT ON ALTIMETER, AIR SPEED, AND RATE OF CLIMB. IF NO EFFECT ON INSTRUMENTS, ALL OR INDIVIDUALLY, CHECK FOR PRESSURE LEAK OR OBSTRUCTION.

HYDRAULIC FLUID CHECK

ACCUMULATOR MUST BE EXHAUSTED TO OBTAIN PROPER FLUID CHECK. DO NOT GO BY LEVEL IN FILL STEM, BUT BY GAUGE IN SIDE OF TANK.

BRAKE CHECK

WITH ONE ENGINE RUNNING FULL POWER, PARKING BRAKE SHOULD HOLD SHIP. IF SHIP MOVES, WORK BRAKES ON AND OFF AT IDLE SPEED AND TRY AGAIN. IF THIS DOES NOT WORK BLEED SYSTEM.

FULL FEATHERING

RUN ENGINE TO 1600 RPM - MANUALLY GOVERN PROP TO MAX. RPM DROP, THEN DEPRESS FEATHERING BUTTON MOMENTARILY, ALLOWING PROP TO COMPLETELY FEATHER. DO NOT ALLOW M.P. TO EXCEED 30 INCHES.

TO UNFEATHER

PLACE PROP CONTROL IN FULL INCREASE RPM. DEPRESS FEATHERING BUTTON UNTIL TAC. READS 850 RPM. RELEASE BUTTON AND PROP WILL INCREASE PITCH.

PVT. D. A. SCHOPP

CLASS 42-8

NORTH AMERICAN GROUP

Group C (42-8)
Arrive 4:00 p.m.
Depart 12:00 m.n.

July 7, 1942

NORTH AMERICAN AVIATION, INC.
MODEL B-25C INSTRUCTION SCHEDULE
FOR U.S. ARMY AIR FORCES SERVICE PERSONNEL

Date	Time	Group	Subject	Instructor	Place
Tues.	4:00-4:30	All	Organization	Staff	Hangar
7/7	4:30-4:45	All	Opening Remarks	Lt. LaSalle	Lecture Room
(1)	4:45-7:00	C-1	General Airplane	Babcock	Lecture Room
	7:00-8:00	C-1	Projects	Staff	Lecture Room
	8:30-12:00	C-1	Shop Work	Staff	Hangar
	4:45-8:00	C-2	Shop Work	Staff	Hangar
	8:30-11:00	C-2	General Airplane	Babcock	Lecture Room
	11:00-12:00	C-2	Projects	Staff	Lecture Room
Wed.	4:00-7:00	C-1	Gen. Power Plant	Croxton	Lecture Room
7/8	7:00-8:00	C-1	Projects	Staff	Lecture Room
(2)	8:30-12:00	C-1	Shop Work	Staff	Hangar
	4:00-8:00	C-2	Shop Work	Staff	Hangar
	8:30-11:30	C-2	Gen. Power Plant	Croxton	Lecture Room
	11:30-12:00	C-2	Project	Staff	Lecture Room
Thurs.	4:00-7:00	C-1	Fuel Installation	Croxton	Lecture Room
7/9	7:00-8:00	C-1	Projects	Staff	Lecture Room
(3)	8:30-12:00	C-1	Shop Work	Staff	Hangar
	4:00-8:00	C-2	Shop Work	Staff	Hangar
	8:30-11:30	C-2	Fuel Installation	Croxton	Lecture Room
	11:30-12:00	C-2	Project	Staff	Lecture Room
Fri.	4:00-7:00	C-1	Heat & Vent	Babcock	Lecture Room
7/10	7:00-8:00	C-1	Project	Staff	Lecture Room
(4)	8:30-12:00	C-1	Shop Work	Staff	Hangar
	4:00-8:00	C-2	Shop Work	Staff	Hangar
	8:30-11:30	C-2	Heat & Vent	Babcock	Lecture Room
	11:30-12:00	C-2	Project	Staff	Lecture Room
Sat.	4:00-6:00	C-1	De-Icer & Anti-Icer	Babcock	
7/11	6:00-7:00	C-1	Review (1-5)	Staff	Lecture Room
(5)	7:00-8:00	C-1	De-Icer Service Film	Staff	Lecture Room
	8:30-12:00	C-1	Shop Work	Staff	Hangar
	4:00-8:00	C-2	Shop Work	Staff	Hangar
	8:30-10:45	C-2	Ee-Icer & Anti-Icer	Osborne	Lecture Room
	10:45-11:45	C-2	Review (1-5)	Staff	Lecture Room
	11:45-12:00	C-2	De-Icer Service Film	Staff	Lecture Room
Mon.	4:00-5:00	All	Weekly Test (1-5)	Staff	L.R. & Hangar
7/13	5:00-7:00	C-1	Engine Performance	Croxton	Lecture Room
(6)	7:00-8:00	C-1	Ham. Prop. Film	Staff	Lecture Room
	8:30-12:00	C-1	Shop Work	Staff	Hangar
	5:00-8:00	C-2	Shop Work	Staff	Hangar
	8:30-11:00	C-2	Engine Performance	Croxton	Lecture Room
	11:00-12:00	C-2	Ham. Prop. Film	Staff	Lecture Room

Lunch Period for Entire Group Will Be From 4:00 - 4:30.

Donald Schopp

Group C (42-8)
Arrive 4:00 P.M.
Depart 12:00 M.N.

July 14, 1942

NORTH AMERICAN AVIATION, INC.
MODEL B-25C INSTRUCTION SCHEDULE
FOR U.S. ARMY AIR FORCES SERVICE PERSONNEL

Date	Time	Group	Subject	Instructor	Place
Tues. 7/14 (7)	4:00 - 5:30	All	Engine Maintenance	Scott Cipolla*	Lect. Room
	5:30 - 7:00	C-1	Wright Film (B-G Spark Plug)	Staff	Lect. Room
	7:00 - 8:00	All	Pre-Flight Instruction	Hadley	Lect. Room
	8:00 - 8:30	All	Lunch		
	8:30 - 12:00	C-1	Shop Work	Staff	Hangar
	5:30 - 8:00	C-2	Shop Work	Staff	Hangar
	8:30 - 10:30	C-2	Wright Film (B-G Spark Plug)	Staff	Lect. Room
	10:30 - 12:00	C-2	Project	Staff	Lect. Room
Wed. 7/15 (8)	4:00 - 8:00	C-1	Instrument Install.	Croxton	Lect. Room
	8:00 - 8:30	All	Lunch		
	8:30 - 12:00	C-1	Shop Work	Staff	Hangar
	4:00 - 8:00	C-2	Shop Work	Staff	Hangar
	8:30 - 12:00	C-2	Instrument Install.	Babcock	Lect. Room
	4:00 - 8:00	X	Pre-Flight & Run-Up	Hadley	Line
Thurs. 7/16 (9)	4:00 - 8:00	C-1	Electrical Install.	Croxton	Lect. Room
	8:00 - 8:30	All	Lunch		
	8:30 - 12:00	C-1	Shop Work	Staff	Hangar
	4:00 - 8:00	C-2	Shop Work	Staff	Hangar
	8:30 - 12:00	C-2	Electrical Install.	Croxton	Lect. Room
	4:00 - 8:00	X	Pre-Flight & Run-Up	Hadley	Line
Fri. 7/17 (10)	4:00 - :00	C-1	General Review (6-9)	Staff	L.R.Hangar
	5:00 - 8:00	C-1	Radio Install.	Croxton	Lect. Room
	8:00 - 8:30	All	Lunch		
	8:30 - 12:00	C-1	Shop Work	Staff	Hangar
	4:00 - 8:00	C-2	Shop Work	Staff	Hangar
	8:30 - 9:30	C-2	General Review (6-9)	Staff	Lect. Room
	9:30 - 12:00	C-2	Radio Install.	Croxton	Lect. Room
	4:00 - 8:00	X	Pre-Flight & Run-Up	Hadley	Line
Sat. 7/18 (11)	4:00 - 5:00	All	Weekly Test (6-9)	Staff	L.R.Hangar
	5:00 - 8:00	C-1	Structures	Funk	Lect. Room
	8:00 - 8:30	All	Lunch		
	8:30 - 12:00	C-1	Shop Work	Staff	Hangar
	5:00 - 8:00	C-2	Shop Work	Staff	Hangar
	8:30 - 11:30	C-2	Structures	Funk	Lect. Room
	11:30 - 12:00	C-2	Project	Staff	Lect. Room
	4:00 - 8:00	X	Pre-Flight & Run-Up	Hadley	Line
Mon. 7/20 (12)	4:00 - 8:00	C-1	Landing Gear	Babcock	Lect. Room
	8:00 - 8:30	All	Lunch		
	8:30 - 12:00	C-1	Shop Work	Staff	Hangar
	4:00 - 8:00	C-2	Shop Work	Staff	Hangar
	8:30 - 12:00	C-2	Landing Gear	Osborne	Lect. Room
	4:00 - 8:00	X	Pre-Flight & Run-Up	Hadley	Line

* Wright Representative

Arrive 4:00 p.m.
Depart 12:00 mn.

Group C (42-8)
July 21, 1942

NORTH AMERICAN AVIATION, INC.

MODEL B-25C INSTRUCTION SCHEDULE

FOR U.S. ARMY AIR FORCES SERVICE PERSONNEL

Date	Time	Group	Subject	Instructors	Place
Tuesday July 21 (13)	4:00 - 8:00	C-1	Hydraulics	Croxton	Lecture Room
	8:30 - 12:00	C-1	Shop Work	Staff	Hangar
	4:00 - 8:00	C-2	Shop Work	Staff	Hangar
	8:30 - 12:00	C-2	Hydraulics	Croxton	Lecture Room
Wednesday July 22 (14)	4:00 - 8:00	C-1	Hydraulics	Croxton	Lecture Room
	8:30 - 12:00	C-1	Shop Work	Staff	Hangar
	4:00 - 8:00	C-2	Shop Work	Staff	Hangar
	8:30 - 12:00	C-2	Hydraulics	Croxton	Lecture Room
Thursday July 23 (15)	4:00 - 5:00	C-1	General Review (10-14)	Staff	Lecture Room
	5:00 - 8:00	C-1	Bomb Installation	Funk	Lecture Room
	8:30 - 12:00	C-1	Shop Work	Staff	Hangar
	4:00 - 8:00	C-2	Shop Work	Staff	Hangar
	8:30 - 9:30	C-2	General Review (10-14)	Staff	Lecture Room
	9:30 - 12:00	C-2	Bomb Installation	Osborn	Lecture Room
Friday July 24 (16)	4:00 - 5:00	All	Weekly Test (10-14)	Staff	L.R. & Hangar
	5:00 - 8:00	C-1	Surface Controls	Croxton	Lecture Room
	8:30 - 12:00	C-1	Shop Work	Staff	Hangar
	5:00 - 8:00	C-2	Shop Work	Staff	Hangar
	8:30 - 12:00	C-2	Surface Controls	Babcock	Lecture Room
Saturday July 25 (17)	4:00 - 6:00	C-1	Gun Installation	Osborn	Lecture Room
	6:00 - 8:00	C-1	Shop Work	Staff	Hangar
	8:30 - 10:15	C-1	Load & Balance	Funk	Lecture Room
	10:15 - 12:00	C-1	Shop Work	Staff	Hangar
	4:00 - 6:00	C-2	Shop Work	Staff	Hangar
	6:00 - 8:00	C-2	Gun Installation	Laslett	Lecture Room
	8:30 - 10:15	C-2	Shop Work	Staff	Hangar
	10:15 - 12:00	C-2	Load & Balance	Laslett	Lecture Room
Monday July 27 (18)	4:00 - 6:00	All	General Review (15-17)	Staff	L.R. & Hangar
	6:00 - 8:00	C-1	Project (Wright Manual)	Staff	Lecture Room
	8:30 - 12:00	C-1	Shop Work	Staff	Hangar
	6:00 - 8:00	C-2	Shop Work	Staff	Hangar
	8:30 - 10:30	C-2	Project (Wright Manual)	Staff	Lecture Room
	10:30 - 12:00	C-2	Shop Work	Staff	Hangar
Tuesday July 28 (19)	4:00 - 5:00	All	Weekly Test (15-17)	Staff	L.R. & Hangar
	5:00 - 8:00	C-1	Project (Ham. Manual)	Staff	Lecture Room
	8:30 - 12:00	C-1	Shop Work	Staff	Hangar
	5:00 - 8:00	C-2	Shop Work	Staff	Hangar
	8:30 - 10:30	C-2	Project (Ham. Manual)	Staff	Lecture Room
	10:30 - 12:00	C-2	Shop Work	Staff	Hangar

(Lunch Period- 8:00 - 8:30)

Daily	4:30 - 8:00	X	Pre-Flight & Run-Up	Hadley	Line

RULES & REGULATIONS

PERTAINING TO B-50 SERVICE SCHOOL

FOR AIR FORCE PERSONNEL

1. Badges issued to personnel are to be worn at all times while in attendance at the school. Badges are to be worn on the left side of outer garment.

2. Personnel attending classes are directed to be in attendance during hours specified on your program.

3. Roll is called each day and at the discretion of the instructors.

4. Students are not permitted to wander about hangar or leave their seats without permission of the instructor in charge.

5. Absence, tardiness, and lack of cooperation will be reported to your Commanding Officer for proper disciplinary action.

6. No smoking is permitted in hangar, hangar washroom, or restricted areas.

7. Smoking is not permitted during any regular class period.

8. Lunches are not to be eaten during class hours. A lunch period is provided in the program.

9. It is directed that all personnel keep off lawn adjacent to Airport and park in front of Airport.

10. Air Force Personnel will be permitted to enter Airport restaurant only during their specified lunch period.

11. Each section and class will be expected to keep and leave the lecture room and hangar in a clean and orderly condition.

12. Possession of newspapers, magazines, etc. is not permitted in school.

13. Cheating in examinations will be cause for immediate elimination from school.

14. No gambling of any form is permitted on school premises.

15. Badges must be returned to Service School Office at conclusion of training period.

R. W. Stolz, Director,
B & A. Field Service School

NORTH AMERICAN AVIATION, INC.

FIELD SERVICE SCHOOL

BANDING ON B-25C

LINE	COLOR OF BANDING
Air Speed	Black
Pitot	Black
Static	Black - Light Green
**Compressed Air	Light Blue - Light Green
De-Icer	Light Blue - Light Green
*Anti-Icer	White - Red
***Fire Extinguisher	Brown
***Fuel (also autosyn)	Red
**Hydraulic	Blue-Yellow-Blue
**Manifold Pressure (also autosyn)	White-Blue
****Oil (also Autosyn)	Yellow
**Oxygen	Light Green
**Vacuum	White - Green
**Vent	Red-Black

CODE

*	Each side of all union connections.
**	Near each union.
***	Near each union and on each side of flexible connections.
****	Near each end.

NORTH AMERICAN AVIATION, INC.
FIELD SERVICE SCHOOL

GENERAL AIRPLANE PROJECTS

1. Exits:

   Find all normal and emergency exits. Indicate on work sheet No. 1-1 the following: front hatch, rear hatch, radio emergency escape hatch, pilots' emergency escape hatch, and bombardier's escape hatch.

2. Furnishings:

   Indicate on work sheet No. 1-2 all normal compartments and furnishings, labeling completely. Bombardier's compartment - two seats. Pilot's and co-pilot's compartment - two seats. Curtain between. Navigator's riding seat and chart board stool, fire extinguisher, drinking containers, re-
11 lief tube, mooring kit, and one flying hood. Curtain between. Radio compartment - seat, fire extinguisher, drinking containers, relief tube, life raft. Armor plate door. Camera compartment - chemical toilet and camera seat. Locate storage provisions for all parachutes and first aid equipment. (NOTE: Locate fire extinguisher in each nacelle.)

3. Oxygen System:

   See diagram and instruction sheet.

4. Handling Project:

   See Handling project, No. 1-4.

   On airplane:

   a. Find all towing fittings, mooring, jacking and hoisting points, etc.
   b. Examine airplane handling kit.
   c. Install mooring rings.
   d. Demonstrate use of tow bar and check operation of tow lock pin.
   e. Find out how to open nacelle doors while ship rests on landing gear.

RESTRICTED

NORTH AMERICAN AVIATION, INC.

FIELD SERVICE SCHOOL

OXYGEN SYSTEM PROJECT

a. Trace out all oxygen lines from nacelles to outlets.

b. Locate all cylinders.

c. Locate all check valves.

d. Locate all filler valves.

e. Locate relief valve.

f. Locate all oxygen regulators.

LABEL ALL ITEMS BY NAME

NORTH AMERICAN AVIATION, INC.
FIELD SERVICE SCHOOL

ENGINE ASSEMBLY PROCEDURE

1. Uncrate Engine.
2. Drain oil, cylinders and sump.
3. Spark plugs.
4. Thermocouple attachment.
5. Tighten and safety all plugs.
6. Lord mounts.
7. Cowl lug assembly.
8. Oil fittings.
9. Install fittings in accessory case.
10. Starter (Type ~~[illegible]~~) G-2
11. Generator.
12. Fuel Pump (Type G-9)
13. ~~Tachometer generator (Type E-4)~~ AUTOSYN
14. Vacuum pump (Type ~~[illegible]~~) B-12
15. Hydraulic pump.
16. Prop. Governor (Type 4L-11)
17. Engine mount.
18. Rear engine baffle.
19. Install engine in mount.
20. Grease Lord links.
21. Fixed coil and connector.
22. Install shroud.
23. Fire extinguisher lines.
24. Oil separator bracket.
25. Starter extension bracket.
26. Starter extension shaft.
27. Adjust shaft adapter.
28. Crankcase breather lines.
29. Oil lines.
30. Oil pressure line.
31. Prop. feathering lines.
32. Anti-Icer lines and check valve.
33. Manifold pressure line.
34. Magneto blast tubes.
35. De-Icer lines and valves.
36. Primer line.
37. Thermocouple lead.
38. Carburetor.
39. Carburetor fittings.
40. Mixing chamber.
41. Fuel lines.
42. Fuel pump drain line.
43. Supercharger drain line.
44. Carburetor vent line.
45. Oil dilution line.
46. Fuel pressure line.
47. Oil separator.

48. Vacuum relief valve.
49. Vacuum lines.
50. Check valve.
51. Disconnect lock.
52. Hydraulic lines.
53. Flap strut.
54. Flap control rods and bellcranks.
55. Prop. Governor cables.
56. Collector Ring.
57. Nose Ring.
58. Flap Ring.
59. Cowl Formers.
60. Connect flaps to bellcranks.
61. Install engine on ship and safety.
62. Electrical wiring.
63. Reseal magnetos.
64. Connect and safety Prop. Gov. Press Switch.
65. Adjust flap control rods.
66. Install tail pipe.
67. Install and rig engine controls.
68. Attach drain lines to firewall.
69. Connect fuel lines.
70. Connect oil lines.
71. Connect vacuum and hydraulic lines.
72. Connect thermocouple lead
73. Stake engine.
74. Electrical connections.
75. Install anti-icer sling.
76. Install propeller.
77. Safety propeller.
78. Rest. bulb oil (Type A-16)
79. Engine installation complete.

NORTH AMERICAN AVIATION, INC.

FIELD SERVICE SCHOOL

POWER PLANT CONTROL CABLE CODE

Engine Controls	Marked	Banding
Throttle	T	Red - White
Carburetor Mixture	M	Blue - White
Carburetor Air	C	Brown - White
Supercharger	B	Black - White
Oil Cooler Shutters	S	Yellow - White
Propeller Pitch	P	Silver - White

TIGHTENING TORQUE VALUES*

TABLE OF LIMITS TL-45 ON WRIGHT ENGINES— ALL MODELS

(Special cases and exceptions to TL-45 are listed in other Tables of Limits)

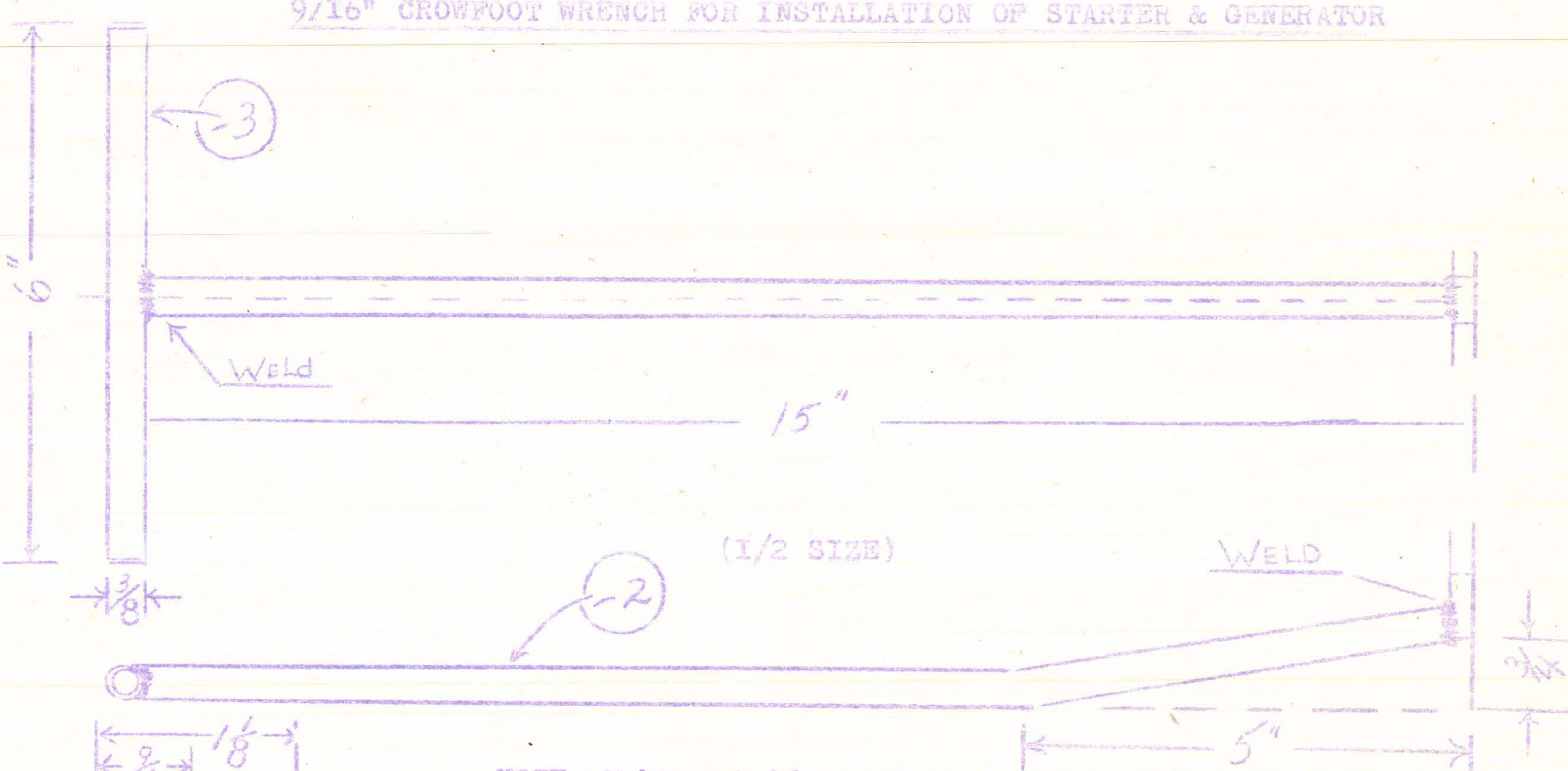
Name	Size of Thread Nut End	Min. Dia. of Thread Root or Neck (Inches)	Min. Rockwell Hardness	Torque Values: Driving Stud, Minimum, In. Lbs.	Driving Stud, Minimum, Cm. Kg.	Driving Stud, Maximum, In. Lbs.	Driving Stud, Maximum, Cm. Kg.	Tightening Nut, Screw, or Capscrew, Minimum, In. Lbs.	Tightening, Minimum, Cm. Kg.	Tightening, Maximum, In. Lbs.	Tightening, Maximum, Cm. Kg.
Standard Studs, Bolts, Screws, and Capscrews											
Button Head Screw	10-32	.1467	B-50	---	---	---	---	20	23.1	25	28.8
Button Head Screw	12-24	.1585	B-50	---	---	---	---	25	28.8	30	34.6
Studs, Bolts, Screws and Capscrews	10-32	.1467	C-19	---	---	---	---	35	40.4	40	46.1
"	12-24	.1585	C-19	---	---	---	---	45	51.9	50	57.6
"	1/4-28	.180	C-26	50	57.6	70	80.7	80	92.3	85	98.0
"	5/16-24	.229	C-26	100	115.2	150	173.0	160	184.5	175	202.0
"	3/8-24	.285	C-26	200	231.0	275	317.0	225	259.5	250	288.0
"	7/16-20	.331	C-26	300	346.0	425	490.0	350	404.0	375	432.0
"	1/2-20	.387	C-26	500	576.0	700	807.0	550	635.0	600	692.0
"	9/16-18	.436	C-26	750	865.0	975	1123.0	825	950.0	875	1008.0
"	5/8-18	.493	C-26	1100	1269.0	1400	1614.0	1125	1297.0	1200	1383.0
Standard Practices for Special Applications											
Cyl. Hold-Dn. Stud	3/8-24	.313	C-32	325	375.0	450	519.0	350	404.0	375	432.0
Cyl. Hold-Dn. Cap-Screw	7/16-20	.330	C-26	---	---	---	---	375	432.0	400	461.0
Cyl. Hold-Dn. Stud	7/16-20	.331	C-32	400	461.0	550	635.0	425	490.0	450	519.0
Rocker Hub Bolt	7/16-20	.371	C-32	---	---	---	---	250	288.0	325	375.0
" " "	15/32-20	.400	C-19	---	---	---	---	250	288.0	325	[illegible]
" " "	9/16-18	.488	C-26	---	---	---	---	300	356.0	375	432.0
Spark Plug	18 mm	---	---	---	---	---	---	450	519.0	500	576.0

*Wright Aeronautical Corp.
Dated [illegible]

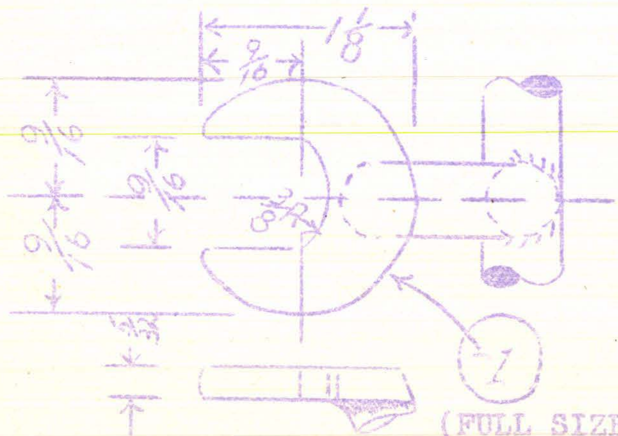
NORTH AMERICAN AVIATION, INC.

B-25C SERVICE SCHOOL

9/16" CROWFOOT WRENCH FOR INSTALLATION OF STARTER & GENERATOR



(1/2 SIZE)



(FULL SIZE)

NOTE: Make outside contour of -1 exactly as shown, using print as template.

H.T. to 160000 & Cad. Plate

MATERIAL SPECIFICATION

-1 One C.M. Steel Sheet - 5/32 X 1 1/4 X 1 1/4
-2 One C.M. Steel Bar - 3/8 Dia. X 15
-3 One C.M. Steel Bar - 3/8 Dia. X6

NORTH AMERICAN AVIATION, INC.

FIELD SERVICE SCHOOL

GENERAL POWER PLANT PROJECTS

1. Cowling and Air Induction.

   a. Remove cowling sheets.
   b. Examine carburetor air induction chamber and control operating shutter.
   c. Note neoprene duct connection and tension of nuts attached to bolts.
   d. Note carburetor installation and control connections to throttle, mixture control, primer solenoid.

2. Engine Mount and Support Assembly.

   a. Find attaching points for installing engine sling
   b. Examine Lord mounts and note installation between mount ring and engine. Find front and rear side on housing of Lord mount.

3. Engine Controls.

   a. Follow cable controls and check tension (35#) except propeller governor cable (15#) to accessories on engine.
   b. Check spring back of controls on control quadrant in cockpit.

4. Exhaust Collector.

   a. Note method of attachment to engine and how supported.
   b. Check expansion joints.
   c. Check split sleeves for tension .020 to .030 clearance. Try to move by hand.

5. Oil System Complete.

   a. On print furnished, trace in oil line for either engine including propeller feathering oil line to governor.
   b. Show oil inlet and outlet to engine.
   c. Determine how to drain oil system.
   d. Determine how to remove Cuno and inspect.

3-3
B-25C

NORTH AMERICAN AVIATION, INC.
FIELD SERVICE SCHOOL

BOOSTER PUMPS

1. Draw booster pump assembly and indicate all parts.

NAME Donald Schopp
GROUP C2-1 BADGE NO. 475
SCORE

INITIAL GROUND RUN-UP, B-25C & B-25D AIRPLANE

Airplane Type ______________________ A. C. No. ______________________

Engine Type ______________________ A. C. No. L. H. Engine ____________

Date of Run-Up ______________________ A. C. No. R. H. Engine ____________

REFERENCE: E.O. 53651, E.O. 53661, A.C. Spec. R-1800-D, T. O. 02-1-29 and 02-35H-1B.

No.	ITEM	CHECK OFF EACH ITEM
	BEFORE STARTING ENGINES	
	CONTROL SURFACES:	
1.	Check for free movement and proper direction of movement of surface and tab, and proper operation of control lock.	
	HYDRAULIC SYSTEM & BRAKES	
2.	Open Accumulator Exhaust Valve and Check Hydraulic Fluid Level at Same Time Check Air Pressure in Accumulators. 400# Required. (Close and Safety Accumulator Exhaust Valve, Caps, Plugs, etc.)	
3.	Check Emergency Air Brake Control Off and Safetied. 375# to 425# Air Pressure required in Tank.	
4.	Free Movement and Feel of Brake Pedals Parking Brake (Set Parking Brake using Hand Hydraulic Pump for Pres.) (Set Chocks 6" in front of wheels and check after run-up to see if brakes hold.)	
5.	Hand Hydraulic Pump. Set Hydraulic Selector Valve at Normal.	
6.	Check Landing Gear Control in DOWN POSITION AND LOCKED (Take Care not to accidentally move Lever from down position.)	
7.	Open Bomb Doors with Hand Hydraulic Pump (Leave Control Lever in Open Position).	
8.	Check Wing Flaps Up and Set Control in Neutral Position.	
	ENGINE CONTROLS: Check for smooth operation, proper springback and correct movement of part operated.	
9.	Throttle.	
10.	Propeller.	
11.	Mixture.	
12.	Throttle, Propeller and Mixture Locks.	
13.	Blower and Blower Control Lock.	
14.	Carburetor Heat Control R.H. & L.H. Engines.	
15.	Cowl Flaps (Set in Open Position with Hand Hydraulic Pump and Return Control to Neutral.)	

NO.	ITEM	CHECK OFF EACH ITEM
16.	Oil Cooler Shutters, R.H. & L.H. Engines	
17.	Engine Fuel Shut-Off Valves (Check Smooth Operation, Index & Locks)	
18.	RADIO OPERATIONAL CHECK:	
18.	Receiver - Command	
	- Liaison	
20.	Transmitter - Command	
21.	- Liaison	
22.	Radio Compass	
23.	Interphone	
	GENERAL	
24.	Fire Extinguisher System O.K. for use.	
25.	Set Oleo Height According to Plate on each Strut	
26.	Put proper amount of air in each Tire.	
27.	Check Airspeed for proper connections.	
28.	Check to see if both inverters are working	
	FOR OPERATING ENGINES USE 100 OCTANE FUEL AND GRADE 1120 OIL (25 GAL. OIL IN EACH ENGINE.)	
	Put 60 Gals, in each Tank and check the Gage for accuracy. (Engine Fuel Shut-Off Valves Off while filling Tanks.)	
29.	L.H. Front: Total Gals., Gage ______ PUmp ______	
30.	R.H. Front: Total Gals., Gage ______ Pump ______	
31.	L.H. Rear : Total Gals., Gage ______ Pump ______	
32.	R.H. Rear : Total Gals., Gage ______ Pump ______	
33.	Check Tanks for leaks and Fuel transfer System.	
	RIGHT HAND ENGINE	
	BEFORE STARTING ENGINE	
34.	Fill Carburetor with Booster Pump.	
35.	Check Fuel Boost Pump for Operation and 6-7 pounds. pressure. (Check during Filling and Starting Operation).	
36.	Check Oil flow feom Capillary Plug on Engine	
	START, WARM, AND STOP ENGINE ACCORDING TO CHECK LIST IN COCKPIT.	
37.	Primer operation.	
38.	Starter and Booster Coil operation.	
39.	Check Master Ignition Switch.	
40.	Run Engine at 1200 RPM for 5 min. without cowl, shut down and check for oil leaks. Install Cowl and continue at 1200 RPM for 5 min. more (10 min. total at 1200 RPM)	
	WHILE WARMING ENGINE AT 1200 RPM CHECK FOLLOWING:	
41.	H ydraulic Pressure (800-1100) ______	
42.	Brake Pressure (1000 - 12000) ______	
43.	FWD Accumulator (800 - 1200) ______	
44.	AFT ACcumulator (800 - 1100) ______	
45.	Cowl Flaps	
46.	Check Landing Flap Operation.	
47.	Operate Propeller Control Several Times until it begin to govern.	

NO.	ITEM	CHECK OFF EACH ITEM
	At 1000 RPM	
48.	Vacuum (3.75 min.) ________	
	AT 1600 RPM	
49.	Volts (28.5 ± .5 ________; Amps (50-60;200 Max.)	
	F. Allen	
50.	Fuel Pressure (6-7) ________	
	IDLE FOR 30 SEC.	
	AT 1800-2000 RPM	
51.	Check Mags (75 RPM drop max.)	
	Actual RPM: Both ________ L ________ R ________.	
52.	Oil Pressure (80-90) ________ at 60° oil temp. min.	
	IDLE FOR 30 SEC.	
	AT 2600 RPM (10 sec. max.) (Cyl. Head Temp.) 260 MAX.	
53.	Propeller governing RPM 2600 ________ at 44 M.P.	
54.	Oil Pressure (80-90) ________	
55.	Fuel Pressure (6-7) ________	
	Vacuum (4.25) max. ________	
	IDLE ENGINE AFTER HIGH POWER FOR 1 MIN.	
	PROPELLER FEATH'RING: START AT 1200 RPM DO NOT EXCEED 27" M.P. OR GO BELOW 400 RPM	
	IDLING AND ACCELERATION	
57.	Adjust idling (450-550 RPM) ________	
58.	Adjust for good acceleration ________	
59.	M.P. at Idling (450-550 RPM)	
60.	Oil Pressure (25 Min.) ________ Oil Temp. ________	
61.	Fuel Pressure (6-7) ________	
62.	Check Stewart-Warner Heater	
	LEFT-HAND ENGINE	
	BEFORE STARTING ENGINE	
63.	Reduce Pressure in Accumulators to 600 Max. by working Wing Flaps in order to check Hydraulic Pump on Left Engine	
64.	Fill Carburetor with Boost Pump	
65.	Check Oil Flow from Capillary Plug on Engine	
66.	Check Fuel Boost Pump for Operation and 6-7 pounds pressure. (Check during filling and starting operation)	
	START, WARM, AND STOP ENGINE ACCORDING TO CHECK LIST	
67.	Primer Operation	
68.	Starter and Booster Coil Operation	
69.	Check Master Ignition Switch	
70.	Run Engine at 1200 RPM for 5 min. without Cowl, shut down and check for oil leaks. Install Cowl and continue at 1200 RPM for 5 min. more (10 min. total at 1200 RPM)	
	WHILE WARMING ENGINE AT 1200 RPM CHECK FOLLOWING:	
71.	Hydraulic Pressure (800-1100) ________	
72.	Brake Pressure (1000-1200) ________	

NO.	ITEM	CHECK OFF EACH ITEM

73. FWD Accumulator (800-1200)
74. AFT Accumulator (800-1100)
75. Cowl Flaps
76. Operate Propeller Control several times until it begins to govern

AT 1000 RPM

77. Vacuum (3.75 min.)

AT 1600 RPM

78. B-25C Volts (28.5 ± .5) Amps (50-60;200 max.)
79. Fuel Pressure (6-7)

IDLE FOR 30 SEC.

AT 1800-2000 RPM

80. Check Mags. (75 RPM drop max.)
    Actual RPM: Both L R
81. Oil Pressure (80-90) at 60° Oil Temp. Min.

IDLE FOR 30 SEC.

AT 2600 RPM (10 sec. max.) (CYL. HEAD TEMP. 260 MAX.)

82. Propeller Governing
    RPM (2600) at 44 M. P.
83. Oil Pressure (80-90)
84. Fuel Pressure (6-7)
85. Vacuum (4.25 Max.)

IDLE ENGINE AFTER HIGH POWER FOR 1 MIN.

PROPELLER FEATHERING: START AT 1200 RPM DO NOT EXCEED 27" MP OR GO BELOW 400 RPM

IDLING AND ACCELERATION

86. Adjust Idling (450-550 RPM)
87. Adjust for good acceleration
88. MP at Idling (450-550 RPM)
89. Oil Pressure (30 Min.) Oil Temp.
90. Fuel Pressure (6-7)

WITH BOTH ENGINES OPERATING CHECK FOLLOWING:

WHILE ENGINES ARE WARMING

91. Operation of Flaps and Indicator (4 times up and down min.)
92. Check functioning of all flight instruments
93. Check A-3 Automatic Pilot
    a. Vacuum - 4.00" Hg. (min.) at 1000 RPM
       5.00" Hg (max.) at 2600 RPM
    b. Hydraulic Pressure 100#/□"
    c. Uncage Gyros
    d. Bleed Hydraulic System by pushing Flight Controls hard over in each direction and holding them there for a few seconds.
    e. Line up all Gyro Indices with Flight Controls held in neutral.
    f. Engage Gyro Pilot Control
    g. Check Auto-Pilot response by rotating Gyro control Knobs
    h. Check all Controls for over-powering by pushing Flight Controls with Auto-Pilot engaged.
    i. Disengage Auto-Pilot after check.

NO.	ITEM	CHECK OFF EACH ITEM
	WITH ENGINES WARM	
94.	Propeller Control Synchronization: Check at 1600 RPM, (3/8" variation at knobs max.) Keep M. P. below 27"	
95.	Throttle Synchronization; With Props at 2000 RPM Check at 30 M. P. (3/8" variation at knobs max.)	
96.	Vacuum (3.75 min at 1000 RPM) (4.25 max. at 2600 RPM)	
97.	High Blower check: Set speed of both Engines at 1500-1600 RPM and shift to High Blower. Set at 30" HG M. P. and shift to Low Blower (min. M. P. drop 1-1/2) Actual Drop L R	
98.	Run Engines at 1100 RPM until each has 30 min. total time.	
99.	Drain Oil Tanks, Feathering Sumps, and Engine Sump	
100.	Clean Fuel and Oil Strainers, Reinstall and Safety	
101.	Check Engine Sump Magnetic Plug, Reinstall and Resafety.	
102.	Remove Cuno, Clean, Reinstall and safety	
103.	Check Hydraulic Fluid Level in Main System (See Item #8)	
104	Refill Fuel and Oil Tanks (Amount as required by Air Corps)	
105.	Make sure that all Caps, Plugs, Doors, and Parts are properly reinstalled and resafetied; all Switches are OFF; Valves properly Set; Safety Belts, Microphones, Earphones, and Loose Parts are in place and Secured; Hatches, Doors, Windows are closed; Radio Dial set properly, Cowling on & Fastened; and ship ready for flight.	
106.	Check Operation of Anti-Icer System	
107.	Check Operation of De-Icer System	
108.	Check Bomb Bay prior to B.B. Tank Installation	
109.	Check Bomb Rack Salvo before B.B. Tank Installation. Then cock all Stations on rack.	
110.	Install B.B. Tank and Check Alignment of Shackles and Hoses.	
111.	Safety Bomb Rack Salvo Lock in Bombardier's Compartment & place Warning Sticker on Pilot's Bomb Release Handle.	
112.	Check Fuel Transfer System from B.B. Tank into Wing Tanks	
113.	Check Fuel Gage on B.B. Tank	

WARNING: THESE ENGINES SHOULD NOT BE RUN AT HIGH POWER FOR MORE THAN 10 SEC. COWLS FLAPS SHOULD ALWAYS BE OPEN CYL. TEMP. 260 MAX. OIL TEMP. 95 MAX. IF LIMIT IS APPROACHED IDLE ENGINE UNTIL IT COOLS DOWN.

REMARKS:

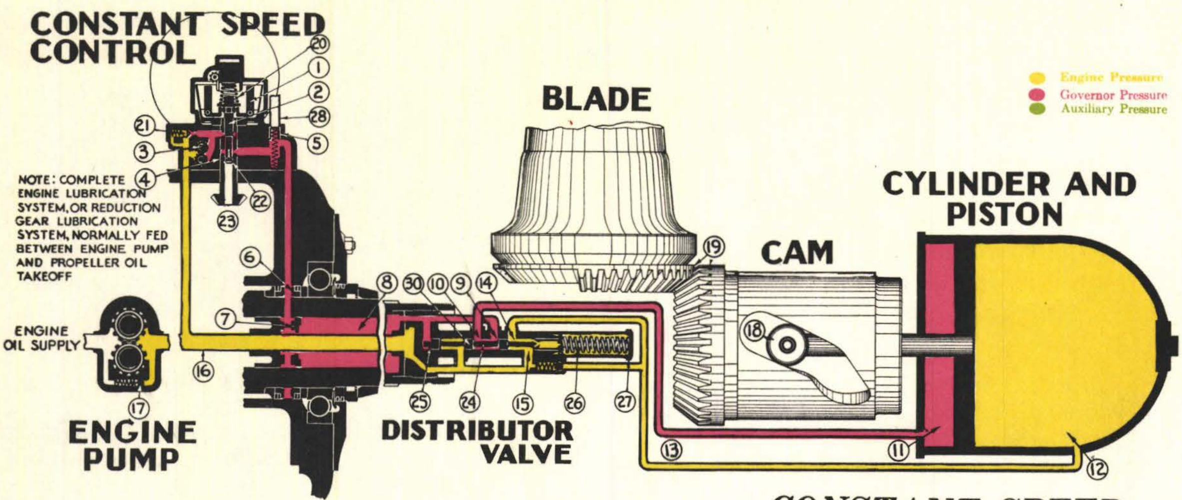


FIG. A.

CONSTANT SPEED

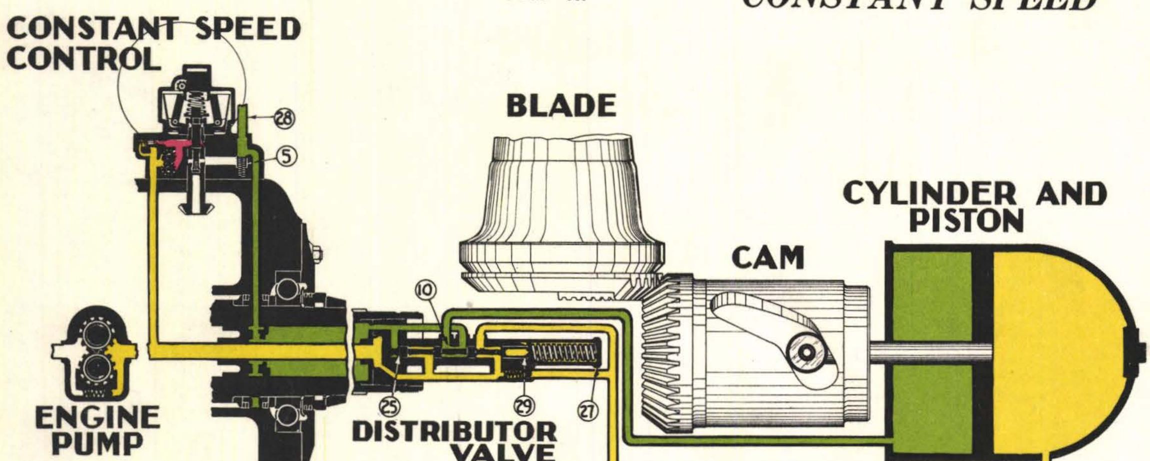


FIG. B.

FEATHERING

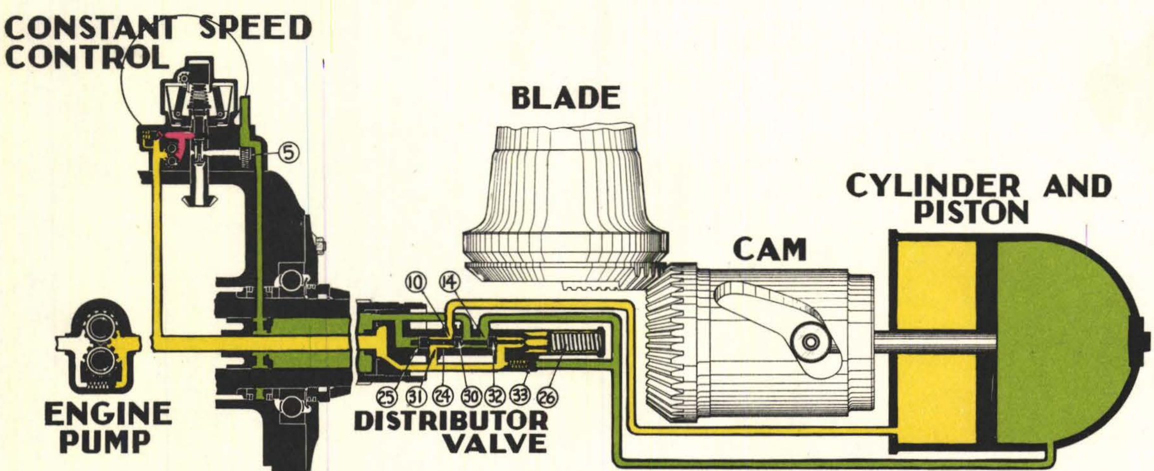


FIG. C.

UNFEATHERING

(1) Governor Flyweight
(2) Governor Pilot Valve
(3) Governor Pump
(4) Hollow Drive Shaft
(5) Governor Cut-off Valve
(6) Engine Shaft Oil Transfer Rings
(7) Propeller Shaft Air Separator Plug
(8) Propeller Shaft Oil Passage
(9) Distributor Valve Port
(10) Distributor Valve Port
(11) Propeller Cylinder — Inboard End
(12) Propeller Cylinder — Outboard End
(13) Oil Supply Tube — Outboard Cylinder End (Schematic Only)
(14) Distributor Valve Port
(15) Distributor Valve Port
(16) Engine Oil Pressure Supply Tube
(17) Engine Pump Relief Valve
(18) Cam Slot Rollers
(19) Bevel Gears
(20) Governor Control Spring
(21) Governor Relief Valve
(22) Governor Drain Port
(23) Governor Drive Gear
(24) Propeller Distributor Valve
(25) Propeller Distributor Valve
(26) Distributor Valve Spring
(27) Distributor Valve Spring Housing
(28) External High Pressure Oil Line
(29) Distributor Valve (Outboard End)
(30) Distributor Valve Land
(31) Distributor Valve Port
(32) Distributor Valve Land
(33) Dome Pressure Relief Valve

NORTH AMERICAN AVIATION, INC.
B-25C SERVICE SCHOOL
MAINTENANCE PROCEDURE FOR A-3 PILOT

1. Problem: Excessive Vacuum (over 5")

Cause	Remedy
a. Air intake filter clogged.	a. Replace with new filter element.
b. Shipping plug not removed from inlet end of air filter.	b. Remove plug.

2. Problem: No operation of all three controls in either direction

Cause	Remedy
a. Low or no vacuum (under 3" Hg.). Vacuum relief valve set too low.	a. Screw in adjusting screw, if increased vacuum does not result, valve is defective. If vacuum does not jump with hand held over air intake of valve, trouble is definitely elsewhere.
b. Pump failure.	b. Repair or replace pump.
c. Broken vacuum line.	c. Locate and repair.
d. Obstruction in vacuum line.	d. Locate and repair.
e. Engaging lever off.	e. Set to "ON".
f. Speed control valves closed.	f. Open speed control valves 2 to 4 turns.

3. Problem: Low or no oil Pressure.

Cause	Remedy
a. Insufficient oil in system	a. Fill sump to required level. After running engines 5 minutes with servo speed control up for oil fed into the system.
b. Pressure regulator out of adjustment.	b. Adjust with speed valves closed. Remove cap and loosen locknut. Screw in to raise pressure, out to lower pressure.
c. Pump intake line or filter clogged.	c. Check line and filter.

4. Problem: Excessive Oil Pressure

Cause	Remedy
a. Oil pressure regulator set too high or regulator stuck.	a. Adjust with speed valves closed. Remove cap and loosen locknut. Screw out to reduce lower pressure. Clean and readjust.

5. Problem: Failure of one of the controls

Cause	Remedy
a. Speed valve closed.	a. Open speed valve.
b. Servo relief valve by-passing.	b. Reset valve according to Reference 5 (a).
c. Balanced oil valve on mounting unit stuck.	c. Remove rear cap and work valve back and forth by hand with oil pressure on, Gyropilot off.
d. Air relay stuck.	d. Clean and replace.

6. Problem: Controls hunting

Cause	Remedy
a. Air in oil system.	a. Reference 6 (a).
b. Sticking oil valve.	b. "Work valve manually" etc. Reference 6 (b).
c. Unbalanced oil valve.	c. Reset valve to neutral.
d. Gyros caged. A caged gyro will precess back and forth against the caging stops, causing the controls to follow.	d. Uncage gyros.

7. Problem: Jerky Control

Cause	Remedy
a. Sticky balanced oil valve.	a. Free valve and clean if necessary. Valve will have to be rebalanced if removed for cleaning.

8. Problem: Control in one direction only

Cause	Remedy
a. Balanced oil valve restricted by dirt.	a. Operate manually to check. Free and clean valve if cause of trouble.

b.	Follow-up or piping reversed.	b.	Connect according to control diagram.
c.	Air leak at air pick-off grommet between control unit and mounting bracket.	c.	Install new grommet and check.

Reference 5 (a)

The conditions which govern the settings of the servo relief valves are: (1) they should open readily in either direction without excessive manual effort to overpower the gyro pilot, and (2) they should not open during normal flight conditions in smooth or rough air. The best settings to meet these conditions will usually be found between 75% and 100% of gyro pilot operating pressure. To set the relief valves, tee in two oil pressure gauges of 300 pounds range, one in each line, to the servo cylinder at the point where the lines from the balanced oil valves are normally attached.

Reference 6 (a)

Move controls back and forth manually with engine running and gyro pilot OFF. Hold each control at one and then the other extreme position for one minute. This permits continuous flow of oil down on servo line, through the by-pass and into the other line, thus carrying any air back to the sump via the exhaust line. The follow-up indices should be set neutral at the start with the controls at neutral.

Reference 6 (b)

Work valve manually until free then hold at each extreme position for about 2 minutes to allow any dirt to be carried back to the sump. This to be done with Gyro pilot engaging lever in OFF position.

NORTH AMERICAN AVIATION, INC.
FIELD SERVICE SCHOOL

INSTRUMENT EQUIPMENT BREAKDOWN

The following discussion covers the disassembly of typical B-25C and B-25D bombardment airplanes. The discussion covers only items pertaining to the instrument system of these types of airplanes.

1. The nose section may be removed at fuselage station 70. Instrument lines affected by this break are air speed (pressure and static) lines to the bombardier's panel and air speed (static) line to glide bombing static selector valve. This static line (to glide bombing static selector valve) will be found on airplanes AC41-12817 and subsequent B-25C and AC41-29848 and subsequent B-25D. On airplanes equipped with A-3 Automatic Pilot, a vacuum line running from an air filter in the nose to the gyro units of the auto pilot will be affected.

The air speed lines to bombardier's panel are to be disconnected at unions immediately forward of station 70. The static line to glide bombing selector valve is to be disconnected at a union immediately forward of station 70. The vacuum line from air filter to auto pilot is to be disconnected at the air filter.

To remove bombardier's instrument panel, disconnect electrical and instrument flexible connections at instruments. Remove screws and nuts holding shock absorbers together. Panel may now be removed.

Free air temperature bulbs may be removed from outside of bombardier's compartment (left side) by disconnecting electrical connections and removing attaching screws.

2. The pilot's and navigator's compartment sections may be disconnected from the center section at fuselage station 224. Vacuum lines should be disconnected at check valves located in left and right wing opening. Air speed lines should be disconnected at unions immediately aft of fuselage station 199 (right side).

Disconnect camera vacuum line between fuselage station 231 and 245-3/16. The thermocouple leads are in two sections from both left and right engines to indicators on the pilot's panel, therefore, the section from the disconnect block at wing station 82 to pilot's panel (both sides) must be unclipped at three places in the center section inner wing before separating center section from fuselage at fuselage station 224.

To remove pilot's instrument panel disconnect all electric and instrument flexible connections at instruments. Disconnect bonding braid at two places. Remove bolts and nuts holding shock absorbers together. Panel may now be removed. On ships equipped with an automatic pilot, the gyro units should be removed from themount assembly by removing the four retaining studs. Disconnect vacuum and hydraulic connections from rear of mount assembly. Mount assembly may then be removed by removing bolts and nuts holding shock absorbers together.

3. The center section consisting of main bomb bay and both nacelles may be disconnected from the fuselage rear section at fuselage station 304. The camera vacuum line should be disconnected immediately forward of station 304.

4. The engines may be removed from the nacelles. Fuel, oil and manifold pressure lines fromengine to autosyn transmitters are to be disconnected at the firewall. Thermocouple lead (section to engine) may be disconnected at disconnect block provided at wing station 82. Tachometer shaft may be disconnected at engine. Clamp supporting tachometer shaft at engine mount to be disconnected. These disconnects are to be made both left and right sides.

A panel containing fuel, oil, manifold pressure and oil temperature autosyn transmitters is located immediately aft of the firewall. This panel may be removed by first removing the oil temperature bulb from oil "Y" drain valve located at bottom of firewall (forward s... and unclipping capillary line from "Y" drain to transmitter. Disconnect flexible connections at transmitters. Remove screws and nuts holding shock absorbers together. Panel may now be removed. Capillary line to oil temperature transmitter should be kept neatly coiled to prevent damage.

A panel containing an autosyn tachometer transmitter and also located aft of firewall may be removed by removing screws and nuts holding shock absorbers together. Tachometer shaft may be disconnected at transmitter before panel is removed. Bonding of the two panels and of the tachometer shaft at the firewall should be disconnected before removal of parts. The above procedure is followed for both left and right engines.

5. The outer wing panel may be disconnected from the ... tion of the airplane at wing station 157. Air speed lines ... connected at unions immediately outboard of wing station 157, ... through hand hole in bottom of wing. Pitot static tube may ...oved from outer panel by unscrewing jam nut at leading edge casting ... disconnecting two "U" clamps at rear casting supporting the tube. Disconnect pressure and static lines at unions and disconnect electrical connection at junction box. Tube may now be slid forw... through leading edge of wing. Access for all disconnects through h... hole in bottom of wing.

The procedure for mechanical assembly or disassembly of ... strument system will be obvious at the point of disassembly.

NORTH AMERICAN AVIATION, INC.

B-25C FIELD SERVICE SCHOOL

AIR SPEED SYSTEM PROJECT

Indicate on drawing:

Pitot tube
Pressure line
Static line
Air speed line moisture trap
Pilot's rate of climb indicator
Pilot's air speed indicator
Pilot's altimeter
Bombardier's air speed indicator and altimeter

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FIELD SERVICE SCHOOL

B-25

ENGINE INSTRUMENT PROJECT

1. Locate the following units on the firewall of each nacelle and connect to engine:

    a. Tachometer shaft to autosyn tachometer transmitter.
    b. Fuel pressure line to autosyn fuel pressure transmitter.
    c. Oil temperature line to autosyn oil temperature transmitter.
    d. Oil pressure line to autosyn oil pressure transmitter.
    e. Manifold pressure line to autosyn manifold pressure transmitter.
    f. Thermocouple lead from engine master cylinder to pilot's cylinder head temperature indicator.

2. Indicate on pilot's panel all of engine instruments.

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FIELD SERVICE SCHOOL

B-25C

INSTRUMENT PROJECT

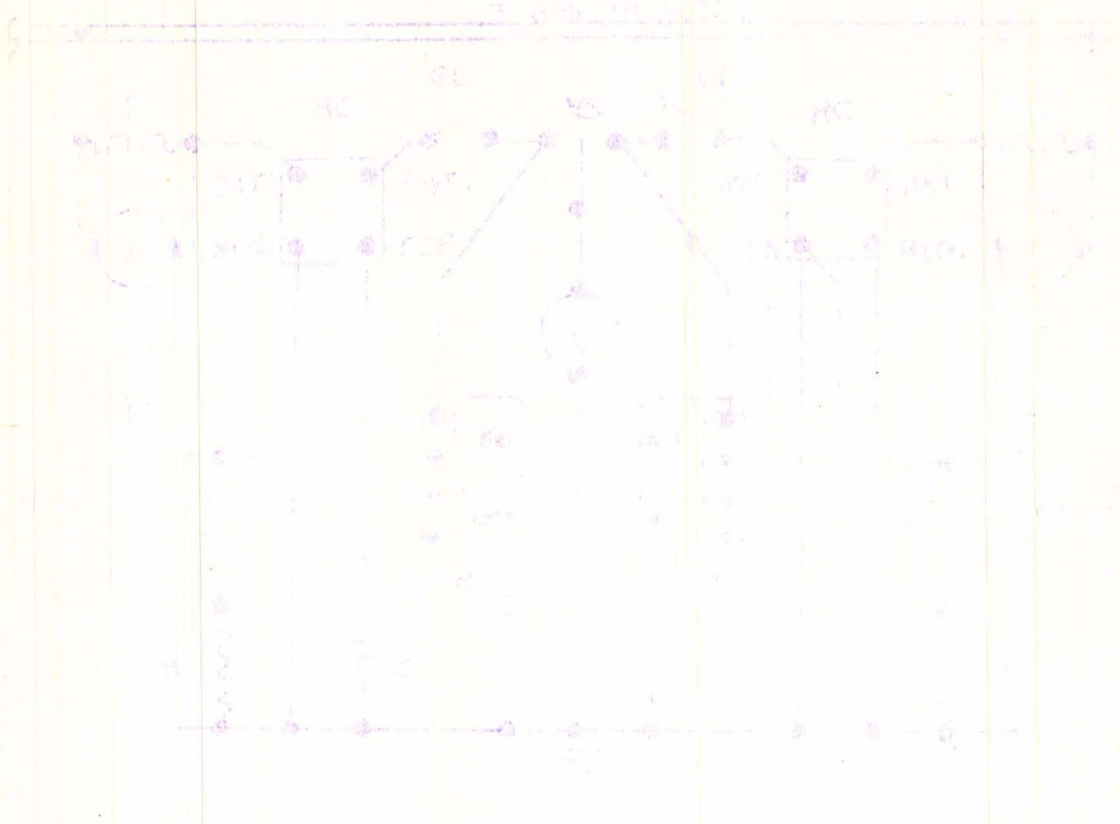
1. On plan sheet furnished sketch in Vacuum System Installation for A-3 Automatic Pilot Equipped Airplanes.

a. Indicate on drawing the following items

Vacuum pump
Relief valve
Oil separator
Oil return to engine
Connection to De-Icer pressure line
Safety valve
Vacuum manifold block
Vacuum air filter
Suction gauge
Bank and turn needle valve

b. Locate also:

Turn indicator
Bank and turn indicator
Sperry directional gyro
Sperry bank and climb gyro
Flight indicator



[illegible] - AMMETER	RC - [illegible]
C - CAPACITOR	[illegible]
GEN - GENERATOR	[illegible]
GS - SWITCH, GENERATOR MAIN LINE	[illegible]
[illegible] - RESISTOR, POTENTIAL EQUALIZER	VS - SWITCH, [illegible]

Donald Schopf
Cr-1
4/75

RESTRICTED

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UPPER TURRET

[illegible] and [illegible]

1. Gunner's eye cushion
2. Adjustable eye piece
3. Adjustable eye piece lock nut
4. Plexiglas canopy
5. Sight prism
6. L.H. gun
7. Elevation motor
8. Interphone switch
9. Charger switch
10. Dead man's switch
11. Control handle
12. Firing trigger
13. Ammunition container
14. Gunner's seat
15. Adjustable foot rest
16. Oxygen outlet
17. Main power switch
18. Azimuth motor
19. Azimuth compensator
20. Brush box assembly
21. Hydraulic Solenoid Control Valve

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7-18
B-25C

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RADIO PROJECT

1. Locate on plan sheet furnished the following items:

   a. All interphone jack boxes -8 and interphone amplifier. (filter & switch)
   b. Command receiver and transmitter and their remote controls. copilot 2 trans 3 rec. nav. comp.
   c. Liaison receiver and transmitter units.
   d. Spare tuning units for liaison transmitter.
   e. Radio Compass receiver and two remote controls. navi & pilot - rec. in nav. comp.
   f. Marker Beacon receiver unit. navi. - light (light on inst panel)

trans transmitting 1 rec. tuning coils 1 rec.

2. Locate disconnect junction boxes.

3. Note the following items.

   a. Location of interphone amplifier tube and service requirements.
   b. Method of removing radio unit and checking security of mounting.

monitor switch tells what frequency you are operating on &

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16-D
B-25C

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FIELD SERVICE SCHOOL

QUESTIONS FOR STRUCTURES LECTURE PROJECT

1. What nominal edge distance should be used for riveting? i.e. From the center line of rivet to the edge of the sheet. Give example.

   Distance is twice the diameter of the rivet. A 1/8" rivet would be 1/4" from the edge.

2. Why should a combination of rivets and bolts in a joint be avoided?

3. What is the best or most desirable fit for a bolt carrying a shear load?

4. It is necessary to add another bolt to a group of 4 1/4" bolts which have .254" drilled holes. What size drill should be used for the added bolt, and what should be the diameter of the hole?

5. Which of the following conditions are detrimental to the strength of a bolted or riveted connection?
   a. Elongated holes.
   b. Lack of sufficient edge distance.
   c. Loose bolts (i.e. The nuts are not drawn up tight.)
   d. Countersunk bolts whose heads do not seat properly.
   e. Bolts with threads bearing completely in one portion of a joint.
   f. Rivets whose shank has swelled between the two sheets of a lap splice.

   All of them

6. Why should sharp corners, scratches, or other indentations in any part be avoided?

   Because lines of force would tend to converge & eventually break.

NAME Donald Schaffe
GROUP C-2-1 BADGE NO. 4034
SCORE

RESTRICTED

QUESTIONS FOR STRUCTURES LECTURE PROJECT (Continued)

7. Give four qualities of a satisfactory straight bushing. (Draw a sketch if necessary.)

1. Should be of metal as hard or harder than surrounding metal.
2. Should have equal space all around. 
3. Should be of non-corrosive metal.
4. Should have a pressed fit.

8. Where should a shoulder bushing be used?

9. Of what purpose is a wing stringer?

Strengthens the skin & transmits load & strain to the spar.

10. Where should the inspection of a damaged plane end? i.e. Is it sufficient to inspect only the apparent damage?

The damage & any dependent part should be examined as well as the surrounding parts.

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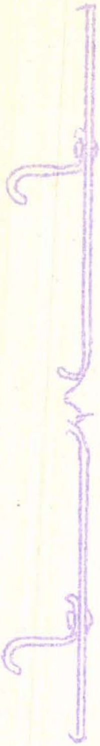
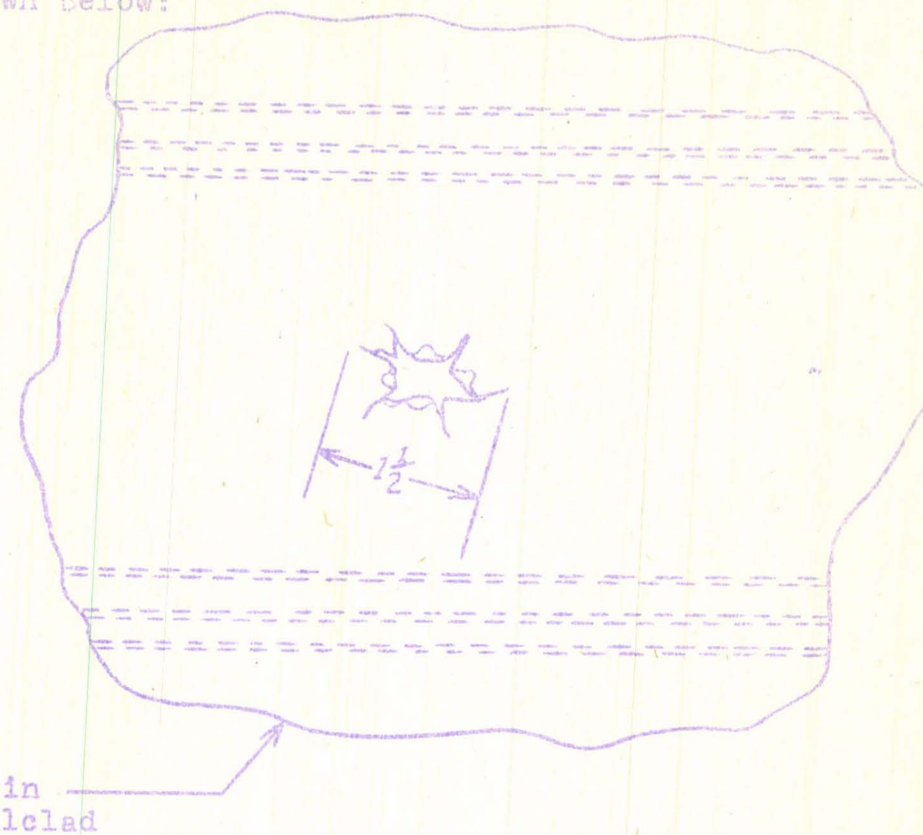
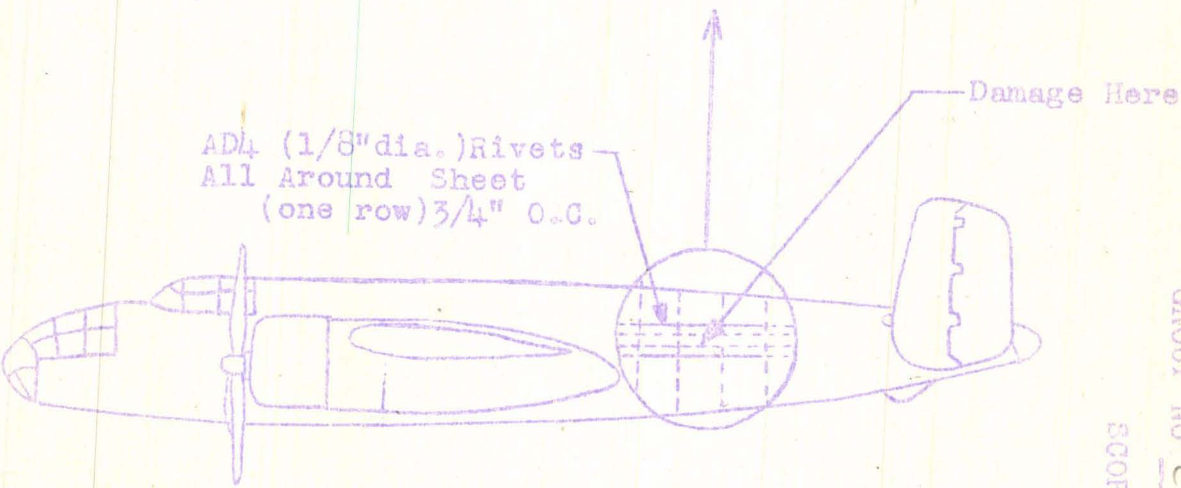
FIELD SERVICE SCHOOL

STRUCTURE REPAIR

2. Sketch a Repair for the Damage Shown Below:







View Showing Location of Damage

NAME Donald Schoff

GROUP NO Cz-1 BADGE NO. 175

SCORE

Donald Schopp #5
Cz-1

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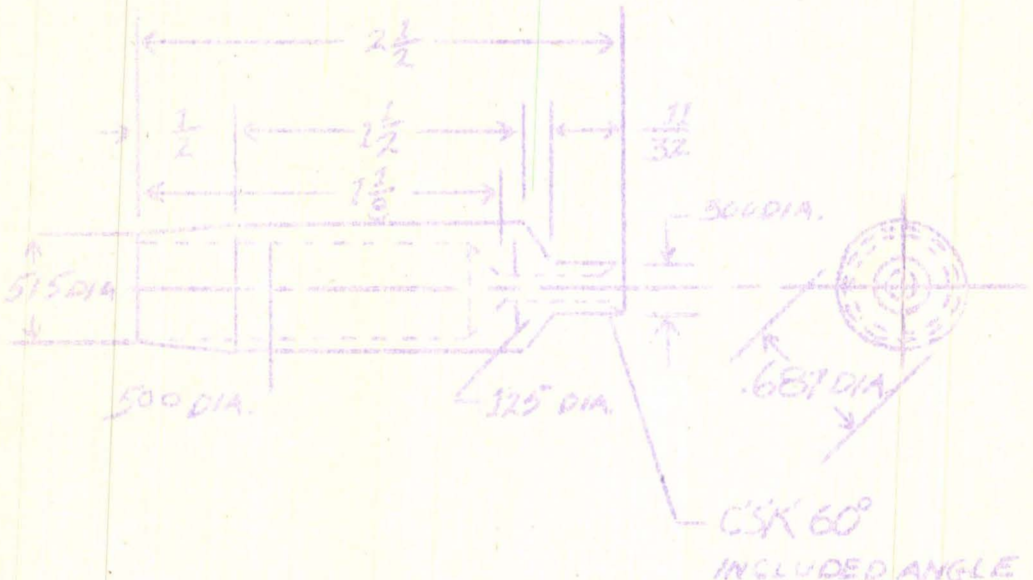
B-25C FIELD SERVICE SCHOOL

VALVE RETRIEVER



S. A. E. 1020 Mild Steel

T.J. 3309

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FIELD SERVICE SCHOOL

SHIMMY DAMPER TROUBLE SHOOTING

In case of slight shimmy the following items should be investigated for play or looseness in the shimmy damper connecting parts.

1. Shimmy Damper:

   a. Check fluid level.

   b. Check for signs of leakage. (Small traces of leakage are not serious.)

   c. Check static position of nose shock strut. If strut is extended too far, release some of the air from the cylinder. This may be necessary when operating from fields at high altitude or where the temperatures are extremely high.

2. Torque Links:

   a. Disconnect torque links at outer end.

   b. Check upper and lower link for side play and looseness at attaching bolts to strut.

   c. Replace all worn bushings or bolts.

   d. Check for broken parts.

   e. Check for looseness in shimmy damper connecting link bolts.

   f. Take up all play in bolts, but do not tighten enough to bind.

3. If shimmy persists, exchange damper from a ship that is working satisfactorily. If shimmy disappears with this exchange, replace with new damper.

4. If shimmy still persists, it may be caused by the wheels or brakes.

   a. Loose nose wheel.
   b. Nose wheel tire under inflated.
   c. Nose wheel out of balance.
   d. Rough or sticking brakes, possible buckled brake plates.
   e. Main wheel out of balance.

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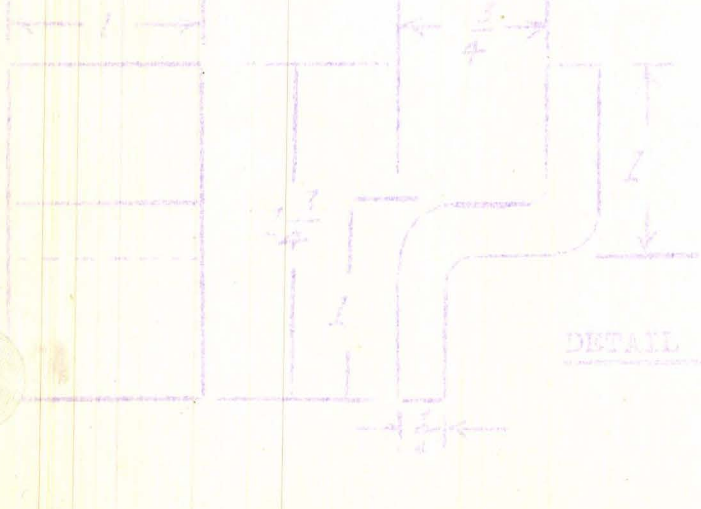
REMOVAL OF WHEEL AND BRAKES

1. Jack up ship.
2. Exhaust accumulator.
3. Have No. 6 BT fitting plugs on hand.
4. Disconnect lines from both brakes.
5. Remove cotter pin from axle.
6. Remove retainer nut from axle.
7. Remove outer brake assembly.
8. Removal wheel.
9. Remove inner brake by removing six bolts from axle flange.
10. Inspect brakes for scaring and over-heat or warpage.
11. Set clearnace of brake at .090.
12. Reverse this procedure to install wheel and brake, being sure you get cotter pin in the brake line bracket in outer end of the axle.
13. Complete inspection of wheel.
14. Bleed brakes to remove all air from system.

[illegible] TIRE INSTALLATION – MAIN LANDING GEAR

BREAK ALL SHARP EDGES

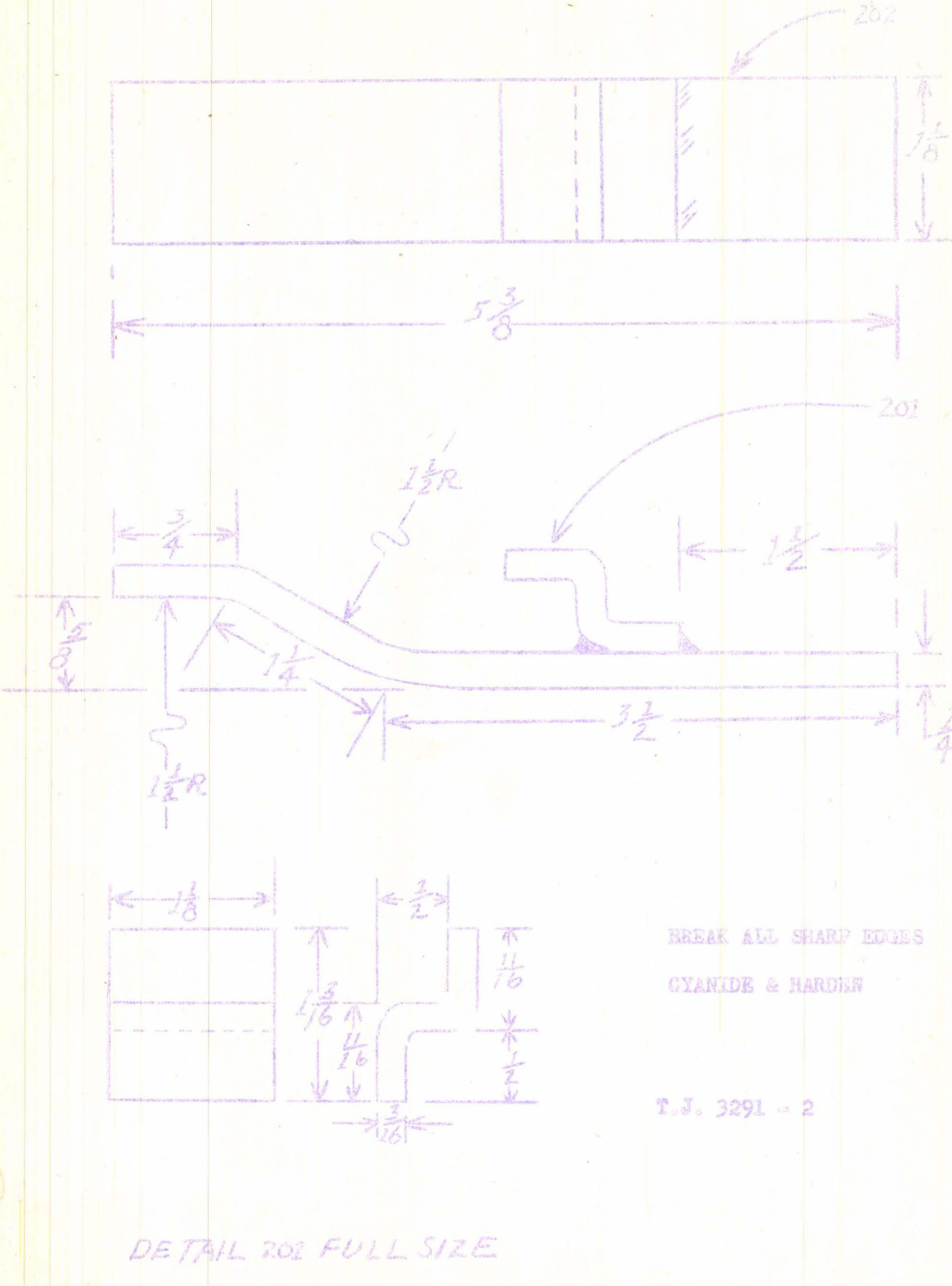
CYANIDE & HARDEN



DETAIL FULL SIZE

NORTH AMERICAN AVIATION, INC.
FIELD SERVICE SCHOOL

CLIP TIRE INSTALLATION & AUXILIARY (NOSE) LANDING GEAR



BREAK ALL SHARP EDGES

CYANIDE & HARDEN

T.J. 3291 - 2

DETAIL 202 FULL SIZE

NORTH AMERICAN AVIATION, INC.

B-25 FIELD SERVICE SCHOOL

INSTRUCTIONS FOR COMPLETE HYDRAULIC CHECK-OUT ON THE B-25C

1. Jack Up Ship:

   A. Provide necessary equipment.
   b. Install jack pads in wing and nose of fuselage.
   c. Check airplane clearance for any obstructions around or under wings, nose, tail, motor nacelles, and propellers.
   d. Jack up under wings, first raising both sides evenly. Also, be sure stands are resting on floor in three places, until tires are clear of floor. Install safety pins in jack stands.
   e. Jack up nose wheel. Be sure all three legs are on the ground during operation. Install safety pin in jack stand.

2. Hook Up Test Stand:

   a. Check accumulators for air pressure.
   b. Open accumulator exhaust valve, and fill reservoir with oil. Then close the exhaust valve.
   c. Check emergency systems for stowage position before starting any hydraulic operation.

3. With emergency selector valve on normal, set timing valve by operating hand pump.

   A. Check all hydraulic units for operation with hand pump before turning test stand on.
   b. Turn test stand on. Check complete system for leaks.
   c. Check unloader valve for correct operation.

4. Check out air brake unit complete for holding pressure and operation.

5. Brakes:

   a. Check brake plates for proper clearance.
   b. Bleed brakes and adjust brake valve pressure.

6. Signals and Indicators:

   a. Set landing gear warning signal switches, and throttle switches.
   b. Set landing gear and wing flap position indicators.
   c. Check timing on landing gear and flaps for up and down travels.

7. Check shimmy damper and nose wheel cam for correct operation.

8. Check emergency lowering system complete - landing gear and wing flaps.

HYDRAULIC CHECK-OUT, Continued

9. After complete check, exhaust accumulators and fill reservoir to full mark on gauge.

   a. Close accumulator exhaust valve.
   b. Lock landing gear control lever in down position. Put all other control levers in neutral position. Build system and brake pressure to normal.
   c. Safety exhaust valve, remove test stand, and safety up valve on disconnect block.
   d. Park brakes. Remove all ladders and stands away from ship.

10. Lowering Ship:

   a. Let nose wheel down first. Keep all three legs of jack stand on ground while lowering.
   b. Lower main gear jacks evenly until wheels are on the ground.

11. Adjust oleos to proper height:

12. Remove jack pads and install wing plugs.

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B-25C SERVICE SCHOOL

INSTRUCTION SHEET: ELECTRICAL FUSE LOCATIONS

Bombardier's Compartment

Bombardier's Switch Box:

1 spare fuse

1. Bomb Signal Lights
2. Bomb Control

Instrument Junction Box:

2 spare fuses
(Caution: All fuses 1 Amp.)

1. Tachometer
2. Manifold Pressure
3. Fuel Pressure
4. Oil Temperature

Pilot's Compartment

Pilot's Switch & Fuse Box:

4 spare fuses

1. Anti-Icer - Pilot's & Bombardier's - Free Air Temperature.
2. Left Landing Light
3. Pilot's & Bombardier's Dome and Call Lights.
4. Right Landing Light
5. Passing & Running Lights
6. Formation and Identification Lights
7. Oil Dilution - Horn Signal - Lower Turret Signal
8. Pitot Heat
9. Propeller Feathering
10. Inter-Phone

Navigator's Compartment

Main Fuse Panel:

4 spare fuses

1. De-Icer.
2. Dome Lights - Navigator's and Aft
3. Starter
4. Landing Gear Position and Fuel level
5. Booster Pumps
6. Cabin Heater
7. Inverters

Radio Compass Junction Box:

2 spare fuses

1. Radio Compass
2. Marker Beacon

Command Set: Fuses are located on each unit.

Radio Compartment

Antenna Reel & Camera Heater: One fuse [illegible]

2 spare fuses

NOTE: All fuses for heated flying suits are next to the control unit, except the camera operator's and tail observer's which are located in the turret power junction box.

Nacelles

Main Power Panels - Left and Right [illegible]

NORTH AMERICAN AVIATION, INC.
FIELD SERVICE SCHOOL

SURFACE CONTROLS

We will include in this outline an explanation of procedure for removal of various flight control units for repair or replacement as well as the effect upon the flight control system by removal of major airplane sub-assemblies, such as outer wing, aileron, rear fuselage, empennage, etc.

1. Removal of control Columns and Torque Tube:

   a. Slack off tension on fuselage aileron system by loosening turnbuckles located at sector just aft of wing rear spar. (Do not disturb rigging of wing aileron cables).

   b. Through access doors on forward side of control columns, disconnect cables from ends of sprocket chains.

   c. Remove pulleys from forging connections column to torque tube and remove pulleys from bracket on center of torque tube, then remove cables.

   d. Remove taper pins through sleeves connecting ends of torque tube to cable horns. Slide sleeves inboard until they clear horn forgings. Then column and torque tube assembly may be removed after ther electrical connections have been broken.

   e. Column to torque tube forgings may be disassembled by removing bolts and rivets which hold these parts together. However, they should never be completely disassembled unless a new forging need be installed.

   f. Swaged tube column may be removed by removing four bolts and four rivets at top of lower forging. The control column head may be removed by removing top cap, the four bolts on the sides and six bolts around the bottom. This will split the head, allowing access to the sprocket, chain, stops and bearings.

   NOTE: The control column and torque tube assembly need not be removed from the ship to overhaul the control column head.

   g. To remove the cable horns from their mountings slack off tension on elevator system by loosening turnbuckles at rear elevator bellcrank located at each side of the fuselage in the extreme rear of the ship.

   h. Disconnect cables from elevator torque tube horns, one located in bombardier's tunnel and one in nose wheel well.

   i. The elevator cables horns may be removed by removing the bolts holding them in the horn support.

2. Removal of Fuselage Aileron Sector Assembly.

   a. Slack off tension and remove all eight cables from this sector assembly.

   b. Remove bolt through spar, sector and bulkhead.

3. Removal of Wing Aileron Sectors:

   a. Slack off wing cables only at turnbuckles at fuselage sector. Do not disturb rigging of fuselage cable circuit.

   b. Disconnect cables from wing sector.

   c. Disconnect push rod from sector.

   d. Remove sector by removing bolt through center bearing.

4. Removal of Rudder Sectors:

   a. Slack off rudder control cables at turnbuckles located on either side of fuselage in rear.

   b. Disconnect cables from sector.

   c. Disconnect push-rod from sector.

   d. Then remove bolt through sector bearing.

5. Removal of Aileron:

   a. Disconnect aileron to sector push rod at aileron end.

   b. Disconnect aileron trim tab control push rods at hinge line of aileron. Then remove hinge bolts and bonding and lift aileron off.

6. Removal of Elevator:

   a. Remove bolt connecting trim tab push rods. (Bolt is on hinge line of elevator).

   b. Remove bolts connecting elevator to horn and torque tube.

   c. Then remove hinge bolts and remove elevator.

7. Removal of Rudder:

   a. Disconnect push rod, running from sector to rudder horn, at rudder end.

   b. Disconnect rudder trim push rods by removing bolt on hinge line. Then remove hinge bolts and bonding and remove rudder.

8. Removal of Empennage Complete.

a. Disconnect elevator push rod from elevator horn. (Rigging of elevator system need not be disturbed.)

b. Disconnect elevator trim tab cables from links behind guard in upper rear part of fuselage on right side of ship.

c. Similarly disconnect rudder trim cables on left side of airplane.

d. Disconnect rudder control cable at turnbuckles on both sides of rear of ship.

e. Also disconnect jumper cable which crosses ship at stabilizer beam.

f. Disconnect rudder lock cables at links on right-hand side of fuselage just forward of elevator bellcrank.

Disconnected cables should be threaded through holes and coiled up to stabilizer beam. Then as far as flight controls are concerned the empennage may be removed.

9. Removal of wing tip does not affect the flight controls.

10. Removal of outer wing panel.

a. Disconnect wing aileron cables at fuselage aileron sector. Do not disturb rigging of fuselage aileron circuit.

b. Disconnect aileron trim tab cables at turnbuckles in engine nacelle aft of wing rear spar.

c. Disconnect aileron lock cables at links in fuselage aft of wing rear spar.

Then as far as flight controls are concerned the outer wing may be removed.

11. Removal of Forward Part of Fuselage. (From wing front spar forward).

a. Disconnect fuselage aileron cables from sector on centerline of ship aft of rear spar. (The wing cables rigging need not be disturbed.)

b. Disconnect aileron trim fuselage cables at links aft of wing rear spar.

c. Disconnect rudder trim tab cables at links behind guard in aft part of ship on left side. Similarly disconnect elevator trim tab cables on opposite side of ship.

d. Disconnect rudder cables from outboard rudder pedals.

e. Disconnect elevator cables from cable take-off horns mounted on control column torque tube. These cable connections are in nose wheel well on right-hand side and in bombardier's tunnel on left-hand side.

f. Disconnect lock system cables at control arm in bombardier's tunnel.

Then as far as surface controls are concerned, the forward part of fuselage may be removed.

12. Removal of Aft Section of Fuselage. (From rear spar of wing aft.)

a. Disconnect rudder cables near aft of fuselage on each side.

b. Disconnect rudder trim tab cables at turnbuckles under guard at upper rear of ship on left side.

c. Also disconnect elevator trim cables on right side.

d. Disconnect elevator cables from elevator bellcrank on each side of ship near rear.

e. Disconnect lock and aileron trim cables from link aft of wing rear spar.

f. Disconnect cables from fuselage aileron sector and remove sector.

g. Disconnect flap sectors (inside fuselage) from inboard flap.

Then as far as flight controls are concerned, the rear section of fuselage may be removed.

In closing we might add that no unsatisfactory reports have been received from the Army on the flight control system of the airplane, indicating that there have been no failures due to design.

NORTH AMERICAN AVIATION, INC.
FIELD SERVICE SCHOOL

SURFACE CONTROL CABLE TENSIONS

The work we are about to perform on the airplane has been designed to afford some practical experience in rigging the surfaces and cockpit control elements to their proper positions and obtaining the proper rigging load in the cables.

The rudders have been thrown out of alignment with each other and the cables have been slacked off. The problem is to realign the rudders and reestablish the proper initial tension in the cable system.

The aileron system leading to the wing has also been loosened. The problem will be to remove the wheel and control column head for chain and bearing inspection. Then replace and rig.

We will not disturb the rigging of the elevator system due to the difficulty with the control column in different groups attempting to rig the elevators and ailerons simultaneously. However, rigging the elevator would involve procedure similar to that employed in rigging other elements of the control system.

PROCEDURE:

Rudders:

1. Set control lock handle in cockpit to "locked" position. Then move rudders to the left or right until the rudders lock in some fixed position. Rudders should be neutral i.e. in alignment with the stabilizers.

2. Adjust push-pull rods until perfect alignment is obtained. Then with rudder pedals in neutral proceed to rig rudder cables. Check tensiometer. Tighten cables at turnbuckles to proper tension.

Aileron:

1. Slack off fuselage aileron system.

2. Remove plates on forward side of control column. Disconnect cables from chain.

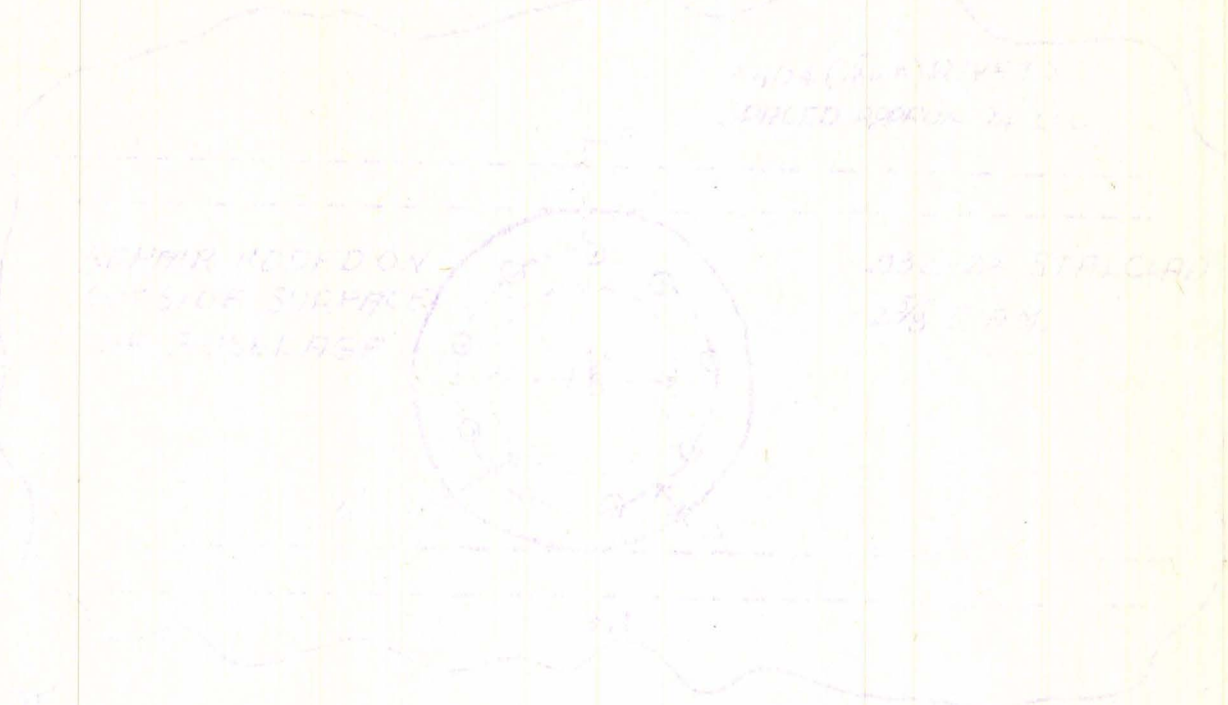
3. Remove wheel.

4. Remove cap from top of column.

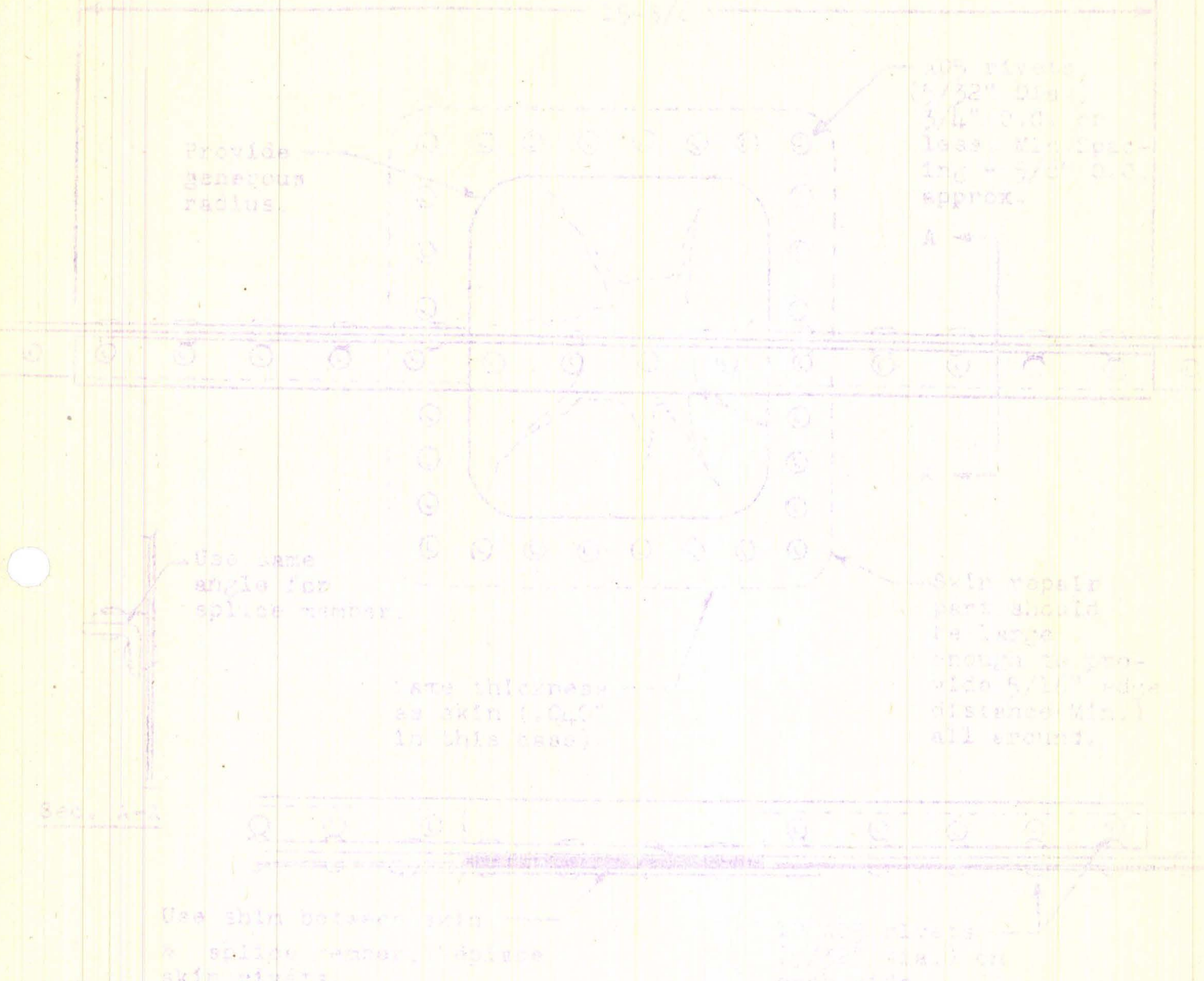
5. 5. Then remove 6 bolts holding head to column and lift off.

6. Re-assemble and re-rig.

Use Reverse Side for Additional Notes on Adjustment:



A satisfactory repair for project [illegible] is as given below.



Show the following information on the above diagram:

1. Length of stringer splice member
2. Riveting for stringer splice member
3. Type of angle used
4. The extent of skin repair member
5. Riveting of skin repair
6. [illegible]

NORTH AMERICAN AVIATION, INC.
FIELD SERVICE SCHOOL

LOWER TURRET

Locate & Identify:

1. Chest Pad of Support
2. Sight eye piece (or eye cushion)
3. Gun Charger Control Valve
4. Steady Grip
5. Main Power Switch
6. Control Handle
7. Control Handle Safety Switch (Dead Man's Switch)
8. Firing Trigger Switch
9. Interphone Switch (push-to-talk)
10. Connection for Main Power Supply
11. Ammunition containers
12. Shifter Shaft for Azimuth Manual Retraction
13. Movable Housing
14. Controller
15. Muzzle of two 50 caliber guns
16. Spider Support
17. Elevation - Compensator Box
18. Ejection Case Chutes
19. Clip Chutes

Add to Sketch:

1. Azimuth Motor
2. Retract Lever
3. Azimuth Compensator Box
4. Elevation Motor
5. Windage Compensator
6. Azimuth Armature Buffer Resistance
7. Retract Limit Switch

GENERAL
AIRPLANE

NORTH AMERICAN AVIATION Inc.

General Airplane LECTURE

B-25 SERIES AIRPLANES

NOTE

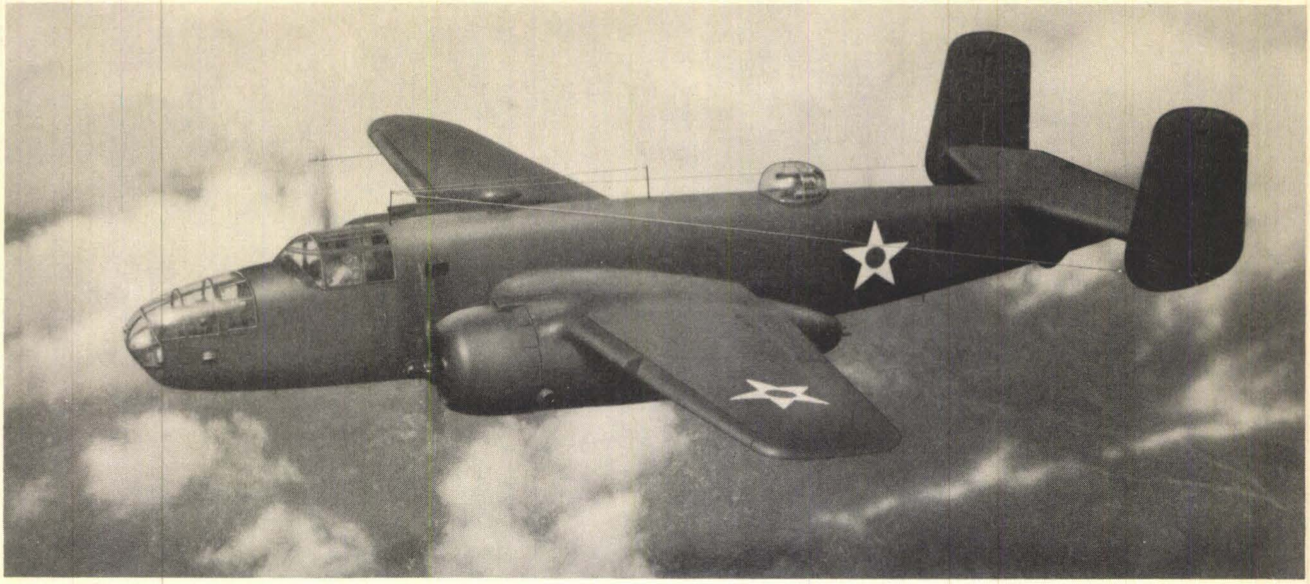
THE INFORMATION CONTAINED IN THIS LECTURE WAS CORRECT AS OF MAY 15, 1942. REFER TO HANDBOOK OF OPERATION AND SERVICE INSTRUCTIONS FOR THE LATEST INFORMATION.

INGLEWOOD, CALIFORNIA

I N D E X

I N D E X (Cont.)

ILLUSTRATIONS

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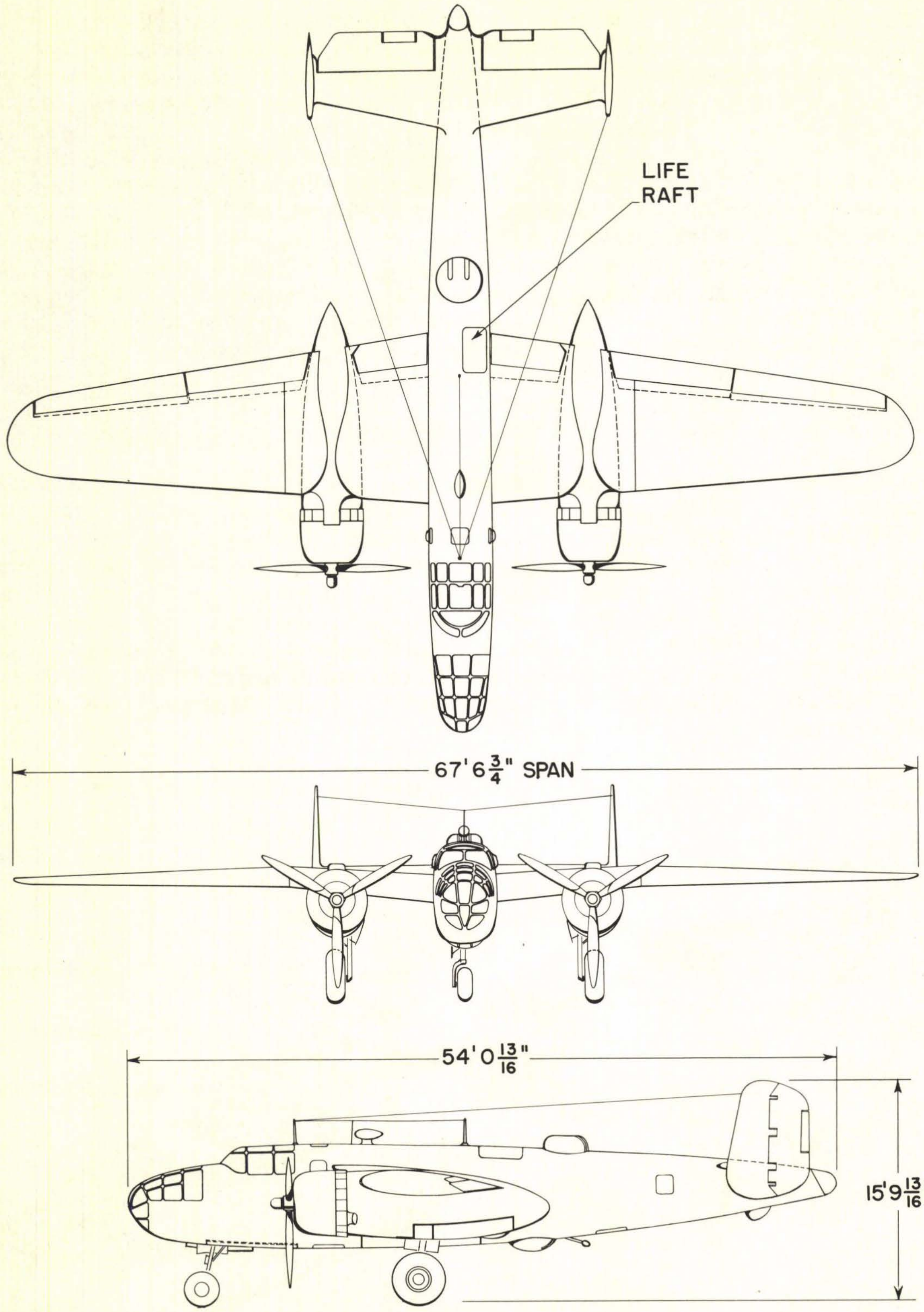


OVERALL DIMENSIONS

ADDENDUM I

The following instructions shall apply for B-25, B-25A and B-25B airplanes only, as exceptions to B-25C and B-25D operation.

STARTING

NOTE: START RIGHT-HAND ENGINE FIRST. OPEN (If closed) "STEAM SHUT-OFF" valve and radiator air shutter when system becomes warm. (B-25A and B-25B Only)

"13. Mixture - IDLE CUT-OFF (Reference pages 3 and 8)

If the mixture control is in any other position, and with a fuel pressure exceeding 5 pounds, the carburetor discharge nozzle will open and allow the engine blower section to become flooded with gasoline; thus, not only flooding the engine, but presenting a fire hazard as well.
(B-25A and B-25B Only)

"19. Set 12-24 Selector Switch to 12-volt position.
(B-25B Only)

"20. Booster pump ON for fuel pressure of 7 to 10 pounds.
(B-25A and B-25B Only)

"22. AS ENGINE STARTS, MOVE MIXTURE TO "AUTO RICH". PRIME WHILE ENGAGING AS REQUIRED. IF ENGINE DOES NOT START, MOVE MIXTURE TO "FULL RICH" AND THEN BACK TO "IDLE CUT-OFF". (Reference page 3).

If priming while engaging starter the mixture control should not be moved.

If not priming, it is permissible to move control as shown, since this will tend to give the engine an additional prime, providing the fuel pressure is above 5 pounds.
(B-25A and B-25B Only)

"25. Booster Pump OFF (Fuel pressure 12 to 16 pounds).
(B-25A and B-25B Only)

"31. At 1600 RPM. Check volts - 14.0 to 14.5
Check amperes- 50 maximum
Check suction- 3.75 to 4.25
(B-25A and B-25B Only)

PILOT'S CHECK-OFF LIST BEFORE TAKE-OFF (Taxi)

"12. Mixture - AUTO RICH.
(B-25A and B-25B Only)

TAKE-OFF

" 4. Fuel Pressure - 12-16 pounds.
(B-25A and B-25B Only)

CLIMBING

" 8. Mixture - AUTO RICH.
(B-25A and B-25B Only)

" 4. Fuel Pressure - 12-16 pounds.
Fuel Booster Pumps ON as required to maintain 12-16 pounds fuel pressure.
(B-25A and B-25B Only)

CRUISING

" 5. The mixture control may be set to "AUTO RICH" or "AUTO LEAN" whichever the operating instructions prescribe. (Reference page 7).

In the "AUTOMATIC" position the carburetor not only compensates for altitude changes, but it will provide proper fuel flow for all power conditions as well.

Since the fuel flow will be metered properly by the carburetor, there is no particular need for either an exhaust gas analyzer or a fuel flow meter on the pilot's instrument panel. These instruments have, therefore, been eliminated in order to simplify the airplane as much as possible.
(B-25A and B-25B Only)

" 2. Fuel Booster Pumps ON as required to maintain 12-16 pounds fuel pressure.
(B-25A and B-25B Only)

"11. Check Volts - 14.0 to 14.5
Check Amperes - 50 Maximum
Check Suction - 3.75 to 4.25
NOTE: In high blower, limit manifold pressure to avoid engine roughness.
(B-25A and B-25B Only)

HIGH POWER - HIGH ALTITUDE
(Reference Page 9, Item 13)

Until more development work is completed on the engine-carburetor combination on B-25, B-25A and B-25B airplanes, which are equipped with Bendix Carburetors, it is recommended that "HIGH" blower operation be kept to a minimum due to the rough condition which will be encountered at high power (above 35 in.MP).

LANDING

NOTE: Close radiator air intake if weather below freezing.
(B-25A and B-25B Only)

" 8. Mixture - AUTO RICH.
(B-25A and B-25B Only)

"10. Supercharger LOW (Locked) and Oil Cooler shutters OPEN as required for 60° - 85° oil temperature.
(B-25B Only)

SERVICE PROBLEMS ENCOUNTERED ON THE POWER PLANT INSTALLATION OF THE B-25 SERIES AIRPLANE

It should be borne in mind that the problems encountered during flight testing are of a nature that result from operation of the engines under extreme conditions, and not as a result of many service hours. Therefore, while many of our problems here are quite parallel to those in service activities, some troubles will occur in service that we cannot anticipate in a flight test program.

However, we have been flying the first B-25 for a period of 17 months with a total flying time of 240 hours to date. The airplane has cracked up twice and has had eight engine changes. All flight testing on this ship has been of an extreme and hazardous nature due to the fact that all plane, engine and propeller performance data was run on this airplane.

The following problems and troubles will be listed in outline form with the symptom and cause listed in order named. In order to simplify, we will work from the propeller aft to the firewall.

I Problem: Propeller not governing or reacts sluggishly to propeller control.

NOTE: Propeller control should be worked several times at 25" to 30" manifold pressure to fill the dome with oil.

Cause:
(1) Cable slipping on governor drum.
(2) Wrong gasket under governor.
(3) Leak in nose section.

II Problem: Propeller will not feather or unfeather.

Cause:
(1) Feathering pump frozen.
(2) Restriction in feathering line.
(3) Low batteries.
(4) Internal leak in engine nose section (transfer rings).

III Problem: Oil Leakage on nose section.

Cause: Propeller not tight or gaskets in backward. Thrust plate gasket leaking.

IV Problem: Oil leakage on dome.

Cause: Dome not tight or old gasket on dome.

V Problem: Setting of propeller pitch at full feather. The correct angle for full feather is 90 degrees, but the blade stops in the hub are set at 92 degrees, so when the dome is set at 90 degrees and installed, the blades must not be set against the stops in the hub, but must be set to 90 degrees or 2 degrees away from the hub stops.

VI Problem: Engine misses or has excessive drop on magneto check.

Cause:
(1) Aero plugs with excessive clearance or shorting.
(2) Burnt ignition wiring due to: 1. Running engines in cross wind. 2. Running engines with cowl flaps closed. 3. Shutting engines off at high head temperatures.

(3) Burnt cigarettes due to same causes.
(4) Fouled plugs due to over priming.
(5) Spark plug wire off.
(6) Ignition switch shorting.
(7) Breeze disconnect plug shorting.
(8) Magneto points dirty.
(9) Defective condenser.
(10) Defective magneto.

VII Problem: Failure of engine to start readily - especially when cold.

Cause:
(1) Electric primer not opening valve.
(2) Not enough pressure to carburetor.
(3) Primer valve sticking open allowing cylinders to flood.
(4) Booster coil not working.
(5) Burnt ignition wires.
(6) Starter clutch slipping.

VIII Problem: Loss of fuel pressure.

Cause:
(1) Defective gauge or line.
(2) Oil dilution valve sticking open which allows carburetor to fill with oil when engine stops.
(3) Vapor in lines and carburetor.
(4) Defective pump.

IX Problem: Propeller control synchronization.

Cause: There is a considerable variation in propeller control cable rigging due to the variation in propeller governor characteristics.

X Problem: Failure of hydraulic system.

Cause:
(1) Hydraulic pump drive shaft sheared.
(2) No oil.
(3) Line or weatherhead broken.
(4) Accumulators discharged or rubbers broken.

XI Problem: Cracks in exhaust collector.

Cause:
(1) Excessive tightening of clamps.
(2) Unequal strains imposed by heat.
(3) Misalignment of support brace running to tail pipe.

XII Problem: Overheating of one cylinder and signs of detonation.

Cause:
(1) Loose intake pipe.
(2) Broken intake gasket.

XIII Problem: Engine roughness and manifold pressure fluctuation in high blower at rated power critical altitude.

Cause:
(1) Characteristic of engine and carburetor combination under such conditions.
(2) Eliminated with Holley carburetors on B-25C.

XIV Problem: Loss of power from engine.

Cause:
(1) Mixtures too rich.
(2) Primer open.
(3) Carburetor air door in scoop not fully closing admitting hot air into carburetor.
(4) Rubber flexible joint between carburetor and scoop broken.
(5) Defective ignition.
(6) Low Octane fuel.
(7) Defective blower absorbing HP.
(8) Valve timing.
(9) Blower in high below 10,000.

XV Problem: Engine fails to accelerate properly.

Cause:
(1) Mixture too rich or too lean.
(2) Accelerating pump defective.
(3) Propeller in full high pitch.

XVI Problem: Oil running out of starter.

Cause: Starter seal defective.

LECTURE BY HAMILTON STANDARD REPRESENTATIVE ON PROPELLERS USED FOR B-25 SERIES

The pitch changing mechanism of the Hamilton Standard, Hydromatic propellers on the B-25 Series is controlled by engine-driven governors to obtain constant engine speed and synchronization of the propellers. Three fundamental forces are used to control the pitch. They are:

1. Centrifugal twisting moment of the blades toward low pitch which is utilized to decrease the blade angle.

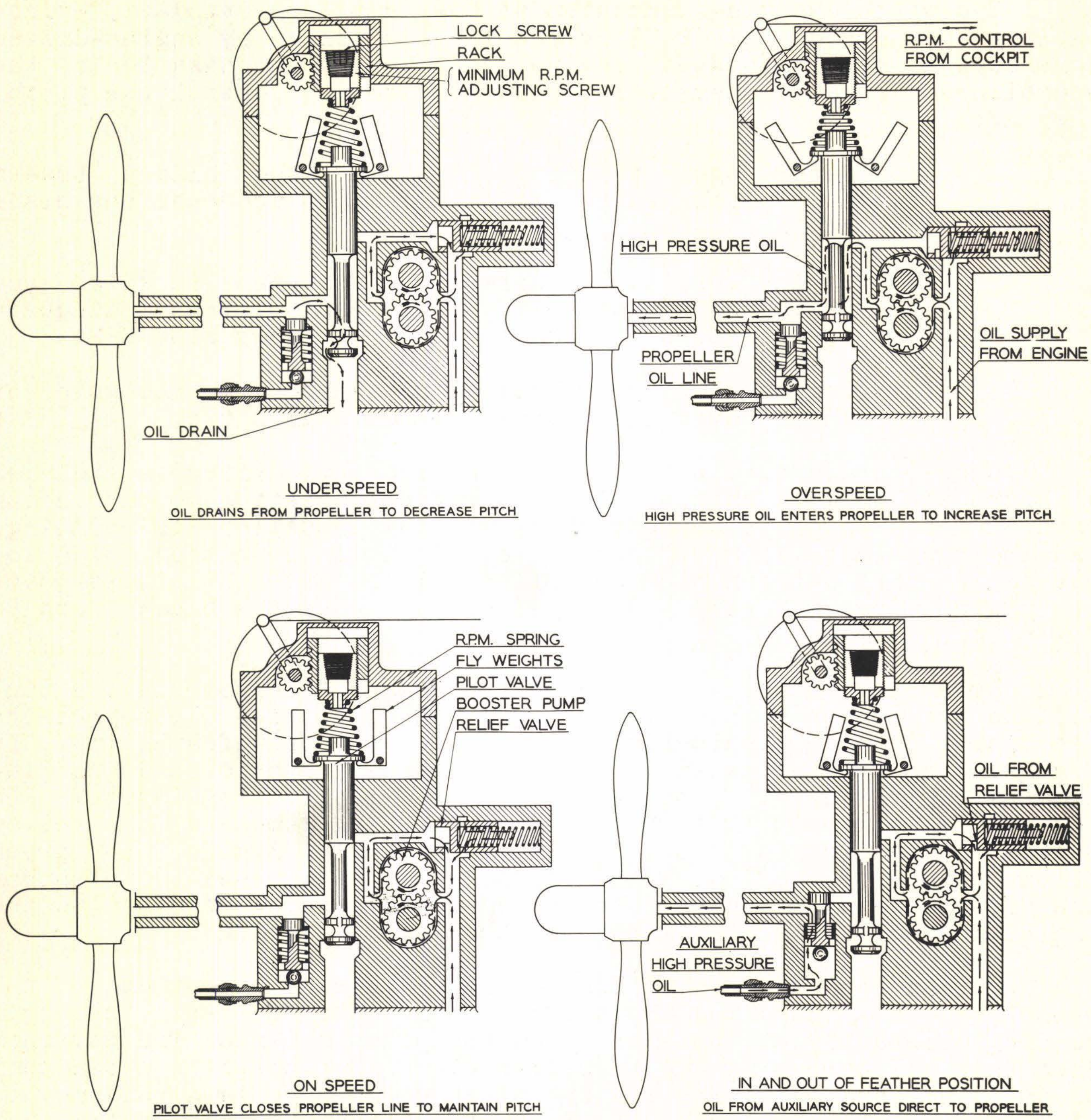
2. Engine oil under normal engine pressure which supplements the centrifugal moment to insure adequate control force toward low pitch at very slow RPM.

3. Engine oil under boosted pressure from the governor which moves the blades towards high pitch.

These forces are indicated in the schematic diagram included with the set of wall charts. The centrifugal twisting moment is the natural force which is present whenever the propeller is rotating, causing the blades to move toward low pitch if permitted to do so. The cam gearing between the propeller piston and the blades moves the piston inward toward the propeller hub when the blades turn to low pitch.

Referring to the schematic chart, Figure A represents the conditions for constant speed governing operation; Figure B represents the conditions for feathering; and Figure C for unfeathering. In Figure A the oil indicated in red is from the governor and that indicated in yellow is from the engine's lubricating system. In Figure B the green oil is from the feathering pump and the yellow oil is from the engine's lubricating system. In Figure C the green oil is also from the feathering pump but is being used to unfeather the propeller in this case; the yellow oil is being returned to the engine's lubricating system through the engine bearings.

During constant speed operation, Figure A, the pitch of the propeller is controlled by the governor so as to keep the engine running constantly at whatever speed the pilot desires. The governor does this by increasing the propeller pitch when there is a tendency to speed up, and by decreasing the pitch when there is a tendency to slow down. In other words, if the engine starts to run faster than the RPM for which the pilot has adjusted the governor, the governor fly weights move outward by centrifugal force, compressing the governor spring and moving the governor pilot valve up. This allows the oil, which is maintained under pressure by the governor booster pump, to flow to the inboard side of the propeller piston, shown in red on Figure A. The pressure of this governor oil is high enough to move the propeller piston outward, thereby rotating the cam and the



CONSTANT SPEED CONTROL
HYDROMATIC TYPE – SCHEMATIC

blades to higher pitch. On the other hand, if the engine starts to run slower than the speed for which the pilot has adjusted the governor, the governor fly weights move inward, allowing the governor spring to extend and move the pilot valve down. This opens the ports in the governor so that the red oil (Figure A) flows back from the propeller to the engine, that is, the governor allows the centrifugal twisting moment to turn the blades toward low pitch.

To feather, oil under pressure from an auxiliary source is fed into the propeller line as shown in green in Figure B. This actuates a spring-loaded valve (#5, Figure B) in the base of the governor, shutting off the governor pressure and making governor inoperative. On the B-25 series the feathering oil is delivered by individual electric motor pumps, one for each propeller,which take oil directly from the engine oil tanks and deliver it under pressure to the respective propellers. The control of this operation is accomplished by push buttons operated by the pilot.

To feather any one of the propellers, the pilot merely pushes in the corresponding button. This actuates a solenoid relay which starts the electric motor pump and delivers oil to the propeller, as shown in green in Figure B. The oil pressure forces the propeller piston out, rotating the blades toward high pitch until the fully feathered position is reached. At this point a mechanical stop in the propeller prevents the piston from moving farther and the green oil pressure immediately starts to rise. A pressure cut-out attached to the governor close to the spring-loaded valve (#5, Figure B) is actuated by this rise of pressure, opening an electrical contact. The opening of this contact breaks the circuit through the holding coil, which is part of the feathering push button and which has been holding the push button in automatically during the feathering operation. This releases the push button and stops the electric pump. As the feathered propeller does not rotate in flight, there is no centrifugal twisting moment and, therefore, no need to maintain oil pressure on the piston to hold it in this position.

To unfeather, the same push buttons and electric pumps are used, but in this case the oil from the pumps is fed to the outboard side of the propeller pistons,as shown in green on Figure C. This is the opposite side of the piston from that on which the feathering oil and governor oil are applied.

Re-direction of the oil from the inboard to the outboard side of the piston is accomplished by the distributor valve as illustrated in Figure C. It is essentially a spring-loaded piston valve which directs the incoming oil to the inboard side of the piston for all operating conditions requiring less than a predetermined maximum pressure. When this maximum pressure is exceeded, the valve moves into its other position and directs the oil to the outboard side of the piston.

The propeller is designed so that during the governing and feathering operations the pressure never exceeds 400 pounds per square inch and this is the basis for adjustment of the distributor

valve. For pressures up to 400 pounds per square inch the valve directs the oil to the inboard side of the piston and for the higher pressures (525 to 600 pounds per square inch) it moves into its other position directing the oil to the outboard side of the piston. This change-over can take place only after the piston has reached the fully feathered position, as the design of the propeller and feathering system makes it impossible to build up more than 400 pounds per square inch on the inboard side of the piston while it is moving outward. In this position the distributor valve also redirects the flow of oil from the inboard side of the piston (yellow oil, Figure C) allowing it to escape into the engine lubricating system through the engine bearings as the piston is moved inward by the green oil.

The inward motion of the piston rotates the blades from their fully feathered position to a lower angle and the propeller begins to windmill due to the forward speed of the airplane. This windmilling, of course, produces centrifugal twisting moment which means that the governor can thereupon take control and the unfeathering operation may be discontinued. In other words, the conditions illustrated in Figure C can revert to those in Figure A as soon as the unfeathering operation has been carried to the point where the propeller is windmilling.

To unfeather a propeller, the pilot actuates the same push button as for feathering. In this case, however, he holds the button in and releases it after the propeller is windmilling. The holding coil is not energized during the unfeathering operation because the pressures used for unfeathering are greater than 400 pounds per square inch and the pressure cut-out maintains the holding coil circuit open.

The electric feathering pumps in the B-25 series are conventional gear type driven by series wound direct current motors operating off the airplane's storage battery. A non-adjustable relief valve set to 1200-1500 pounds per square inch is integral with each pump, the purpose of which is to prevent damage to the system in case of a blocked line or other obstruction to flow. It is simply a safety valve, not a pressure regulator. A high-current fuse is installed in the motor circuit to protect against possibility of stalled motor fire. The feathering pumps are mounted in the respective engine nacelles near the oil tanks from which they draw oil for feathering and unfeathering the propellers.

Adjustment of the constant speed control is accomplished by a system of cables and pulleys connecting the governors on the engines with levers in the cockpit. The extreme forward position of the levers sets the governors to take-off RPM, and the rearward position sets them to minimum RPM. A minimum speed of approximately 1100 RPM has been selected to permit warming up a cold engine after unfeathering in flight without danger of overspeeding.

To prevent oil congealing in the propeller domes during extremely cold weather, all propellers are reworked by Hamilton Standard to incorporate four (4) #68 drill holes in the actuating piston as per Hamilton Standard Drawing No. 54778-2 and T.O. 03-20CC-3. This allows the warm oil to circulate through the dome and yet does not allow enough leakage to prevent proper functioning of the propeller.

MAINTENANCE AND OPERATION OF R-2600-9 AND R-2600-13 ENGINES INSTALLED IN THE B-25 SERIES

I. CONSTRUCTION:

The R-2600-9 engine is a development of the Wright Cyclone, single-row, radial engine and is a double-row, 14 cylinder engine. The term R-2600 designates it as a radial with 2600 cubic inch displacement, having a 6-1/8" bore and a 6-6/16" stroke. The construction of this engine is as follows:

A. Power Section:

The engine has the conventional type, Wright Cyclone, air cooled cylinders. The barrels are forged steel with machined fins and the heads are cast aluminum, with the fins integrally cast. The barrel and head are threaded with a male and a female thread respectively, after which the head is heated to high temperature and attached to the barrel with a shrink fit. During the assembly of barrel and head, the valve seats are also shrunk in. The seats are steel, with a stellite face. The valves are colbalt chrome steel with stellite face and the exhaust valves are sodium cooled. All valves are retained in the cylinders by three coiled springs. The valves are actuated by forged steel rocker arms mounted on ball bearings linked by push rods to the cams.

1. Pistons: Pistons are forged aluminum alloy of the uniflow type. The cooling of the pistons is accomplished by the transmission of heat from the piston head by oil which is thrown into the cylinders by means of crankshaft jets and then drops into circulating oil. There are 6 rings on each piston; the upper three are compression rings, the next two are oil control rings, and the lower ring is an oil scraper ring.

The power is transmitted from the pistons to the crankshaft by means of connecting rods. Each bank of cylinders operates from one master rod and 6 articulating rods. The master rods are located in cylinders #1 and #12. They are attached to the pistons by means of lapped piston pins which are locked by coiled spring retainers.

2. Master Rods: Master rods are single piece forged steel of the banjo type,having Kelmit metal bonded bearings on a steel shell. The master rod bearing is an end seal type which supplies lubrication to the articulating rod knuckle pins by means of an oil radial passage leading directly to the knuckle pins.

3. Crankshaft: The crankshaft is made in three sections front and rear cheeks and the center section, which carries the master rod crank pins. Both the front and rear cheeks are assembled to the center section and secured by clamp bolts drawn up to a stretch of .008". Each crank cheek also has the conventional Wright type dynamic counterweights attached. The center section of the crankshaft has bored crank pins which act as oil reservoirs to the

bearings. Also, the center main bearing journal has two jets which spray oil into the cylinder barrels, one for each bank. The crankshaft is mounted on three large diameter roller bearings -- front, center and rear.

4. Crankcase: The main power section is made up of three forged steel sections which are bolted together inside the case. The front and rear sections carry the front and rear crankshaft bearings and also on the outside provide a bearing journal for the cams to ride on.The center section provides a bearing housing for the crankshaft center main bearing. All cylinders are secured to the crankcase assembly cap screws rather than studs.

B. Nose Section:

The power is transmitted from the crankshaft to the propeller shaft by means of reduction gears located in the nose section. The propeller shaft speed is reduced to 9/16 the speed of the crankshaft. Reduction of the crankshaft speed is accomplished by means of twenty pinion gears mounted on the propeller shaft, operating between the large crankshaft bell gear and a stationary gear secured in the nose section. Lubrication to reduction gear pinions is by means of passages from the propeller shaft rear bearing. The nose assembly housing also provides a drive for the propeller governor.

For test purposes a torquemeter unit can be installed in the same nose section housing. This device is for determining the brake horse power, or B.M.E.P., whichever is desired.

C. Rear Section:

The rear section is made up of three units, i.e., supercharger front and rear sections and the rear cover. The supercharger front section is secured directly behind the rear crankcase section. This unit contains the diffuser, the impeller and intake pipe outlets. The supercharger rear section contains the intake from the carburetor and the two-speed supercharger clutches. The clutches are driven from a gear train coupled to the crankshaft by means of a spring-loaded tail shaft gear. In addition to the supercharger two-speed clutches,the tail shaft drives all the engine accessories, i.e., magnetos, fuel pump and tachometer, oil pump, generator and dual accessory drive.

The clutches which drive the supercharger impeller are geared 7:06 low blower ratio and 10:06:1 in high blower. They are hydraulically engaged by engine oil pressure controlled by a two-way valve mounted integral with the oil pump.

The rear cover provides mounting pads for magnetos, starter, generator, vacuum and hydraulic pumps.

II. OPERATION:

After the engine is completely installed in the plane,the

following precautionary inspection measures should be strictly adhered to.

A. Check magneto ground wires to insure that correct circuits and connections have been made.

B. Fill the oil tanks with the prescribed grade of oil, Army and Navy Specifications #5932, grade 1120.

C. Fill the fuel tanks with the correct octane fuel, Army and Navy Specifications #9531. (100 Octane). Be sure that the tank capacity gauges coincide with the approximate amount of fuel pumped into tanks. Check for fuel leaks.

D. Previous to starting, pull propeller through for at least four complete revolutions. This procedure is to insure there is no superfluous oil in lower cylinder combustion chambers.

E. Inspect the throttle and mixture controls for correct action and travel throughout the entire range. Check for two-speed supercharger selector valve control for positive travel. Head the plane into the wind and open cowl flaps.

The complete starting procedure will be given in the lecture on Engine Performance.

Check the two-speed blower for correct functioning in the following manner. With the propeller in full low pitch position, close the throttle completely, move the clutch control lever to the "high" position, and lock. Open the throttle to obtain not over 30" mercury manifold pressure. When the engine speed has stabilized, observe the manifold pressure and shift the blower control to "low" position without moving the throttle. A sudden decrease in manifold pressure is an indication that the two-speed supercharger drive is operating correctly. Prolonged high blower operation should not be conducted on the ground because the cylinder cooling is insufficient. Do not exceed cylinder head temperature of 260°C. When changing the blower control make the change as quickly as is possible to avoid unnecessary slippage, which might cause the clutch plate faces to burn and make the drive inoperative. If it is necessary to check the propeller for feathering and unfeathering, proceed as follows:

1. Open the throttle to obtain 1600 RPM, approximately 20" HG manifold pressure. Move the governor control into full high pitch position. This will decrease the speed to 1000 -- 1100 RPM. Push the propeller feathering button, and a further decrease in RPM and an increase in manifold pressure will be noted. When the propeller has reached full feathering position, the feathering booster motor will automatically cut out. To unfeather, push the feathering switch button and hold until an increase in RPM is noted. When the speed has increased to 1000--1100 RPM, return the propeller governor control to full low pitch position. If it is necessary to repeat the check, allow the engine to cool off before repeating the check.

2. Normally, the time elapsed for feathering is 9 - 15 seconds and approximately the same time is allowed for unfeathering.

3. After all checks have been satisfactorily conducted and it is desired to stop the engine, allow the cylinder heads to cool to approximately 190°C, open the throttle to 1000 RPM, put the carburetor mixture control in idle cut-off position, which will stop the fuel flow. After the engine stops rotating, turn off the ignition switch. It is desirable to stop the engine about 1000 RPM for two reasons: The idle cut-off is more assured and also permits the scavenger oil pump to pick up the accumulated oil in the sump.

III. INSPECTION ROUTINE:

In order to obtain maximum reliability and service from engines, a regular schedule of inspections and overhauls should be maintained. Serious failures may arise from minor causes which a few minutes inspection could have averted.

A. General:

One of the items of the various inspections is the checking of the tightness of miscellaneous nuts. Experience has indicated that in a great many cases of bolt and stud failures on engines, the cause of the failure has been excessive tightening of nuts. For this reason it is recommended that nuts should not be tightened further if they are already secure; and when the correct tightening torque load is listed in the Table of Limits, this torque should be used. A number of torque indicating wrenches are available, some of which have a scale in inch-pounds, and some have an arbitrary scale which can easily be converted to inch-pounds. Each overhaul base and inspection base should have at least one wrench of this type on hand.

B. Starting Inspection:

See Chapter on Starting and Normal Operation.

C. Daily Inspection:

1. See that the ignition terminals are secure. The terminal nuts should be only slightly more than finger tight.

2. See that the ignition ground wires are secure.

3. See that the throttle, mixture and clutch controls are free throughout their entire range.

4. Examine the exterior of the engine carefully for loose nuts, loose or leaking fuel and oil line connections, or other conditions which are abnormal.

5. Make certain the fuel and oil supplies are sufficient.

6. Check the rated RPM, remembering that it will vary somewhat with atmospheric changes and wind direction.

7. See that the engine operates well on either magneto.

8. Check the oil pressure, oil temperature, and gasoline pressure to see that the operation is normal.

9. Open the blow-out valve in the supercharger pressure gauge line at regular intervals. This valve should be opened for a period of ten or fifteen seconds with the engine idling.

D. Fifty Hour Inspection:

In addition to the daily inspection, the following items should be checked every fifty flying hours unless otherwise specified:

1. Compression: Check compression on each cylinder, removing the front spark plugs from all cylinders except the one being tested. This should be done before the engine has thoroughly cooled after running. This item may be omitted on alternate inspection periods.

2. Valve Gear: Remove the rocker box covers and check the valve rocker clearances. Reset any clearances which are not within the specifications. The engine should be cold when checking or setting these clearances. Before reinstalling the rocker box covers, fill the rocker boxes and push rod housings with oil.

3. Ignition:

(a) Check the spark plugs for fouling and proper gap. Do not disassemble plugs unless absolutely necessary. Check center electrode for tightness. Reset the gap. When checking spark plugs for tightness between the shell and core use wrenches designed for this purpose. Do not use excessive pressure.

(b) Check the magneto points.

(c) Check over the ignition wiring for defective insulation.

4. Lubrication System:

(a) Drain the oil tank and fill with fresh oil.

(b) Remove the sump plug and screen for inspection and cleaning. Inspect magnetic plug for trapped particles.

(c) Clean oil cooler.

(d) Inspect all oil lines and fastenings.

(e) Inspect the lubricating felt attached to the magneto breaker cam followers. If this felt is soft and shows oil on the surface when squeezed between the fingers, no additional lubricant is needed. If this felt is dry, however, apply a small amount of oil to the portion of the felt attached to the cam follower main spring. Use just enough oil to make the felt soft and so oil can be brought to the surface by squeezing. Do not give it all it can hold. It is recommended that the best available grade of medium bodied engine lubricating oil be used. Lubricant of viscosity S.A.E. 30 is suitable for average conditions and S.A.E. 20 for cold weather operation. When possible always choose a time for oiling when the engine and magneto are warm. Never permit oil to reach the breaker contacts, as it would cause pitting, rapid wear and interference with magneto operation. Keep the rest of the breaker mechanism clean and dry. Wipe the interior of the breaker housing clean before replacing cover, but do not permit lint or other foreign matter to lodge on the contacts. The ball bearings are packed in grease and need no additional lubricant between overhauls.

(f) Remove the engine oil strainer and clean the entire assembly. Insufficient oil cooling may be traced to an accumulation of sludge or other foreign material in the airplane oil system. This sludge or foreign material is difficult to remove as it is not soluble in gasoline or other commonly used cleaning or flushing solutions. It is recommended that the airplane oil system be thoroughly cleaned at the time of each engine change or when oil foaming has been experienced. The use of water mixed cleaning solutions, most of which contain either soap compounds or caustic soda, is not recommended. The use of a 50-50 carbon tetrachloride benzol mixture for cleaning and flushing oil system, except in the engine, is recommended. After using this cleaning solution the oil system must be thoroughly dried out with compressed air to insure that the carbon tetrachloride is completely evaporated. In using this material it is recommended that the oil system first be drained completely and blown out with steam. It is recommended that the oil cooler be removed from the system and cleaned separately. The solvent should be introduced into the system

while the system is hot. Circulate the solvent for approximately 15 minutes using a hand pump. Drain the solvent from the system and blow out the lines with steam and dry the lines thoroughly with compressed air. Repeat these operations if necessary and make sure that all lines are thoroughly dried before refilling with fresh oil. If the carbon tetrachloride is not available, a mixture of one-half of 90% benzol and one-half of aviation gasoline may be used as a substitute. This mixture, however, is not recommended because it is highly explosive. In any case extreme care must be taken to prevent fire. Benzol mixtures introduce difficulties in handling and extreme care must be exercised to prevent injury to the operator.

5. Fuel and Induction System:

(a) Remove air screen and rinse in a pail of gasoline.

(b) Remove the carburetor fuel strainer and clean. Clean the external fuel strainer.

(c) Clean fuel tank sediment bulb.

(d) Check the fuel lines and connections to ascertain that they are secure and free from leaks.

(e) Check the carburetor for tightness.

(f) Check the air heater control and duct for tightness.

(g) Check the intake pipe cap screws and packing nuts for tightness.

(h) Check the carburetor and heater controls and lubricate all joints and bearings.

(i) Check all drain lines for tightness and clear passages.

6. Exhaust System: Check the exhaust pipes, exhaust manifold and tail pipes for tightness and cracks.

7. External Nuts: Check the following for tightness.

Accessory flange nuts
Tappet retaining nuts (every 100 hours)
Propeller hub on crankshaft
Engine Mounting bolts
Cylinder flange nuts (every 100 hours)
Thrust bearing nut

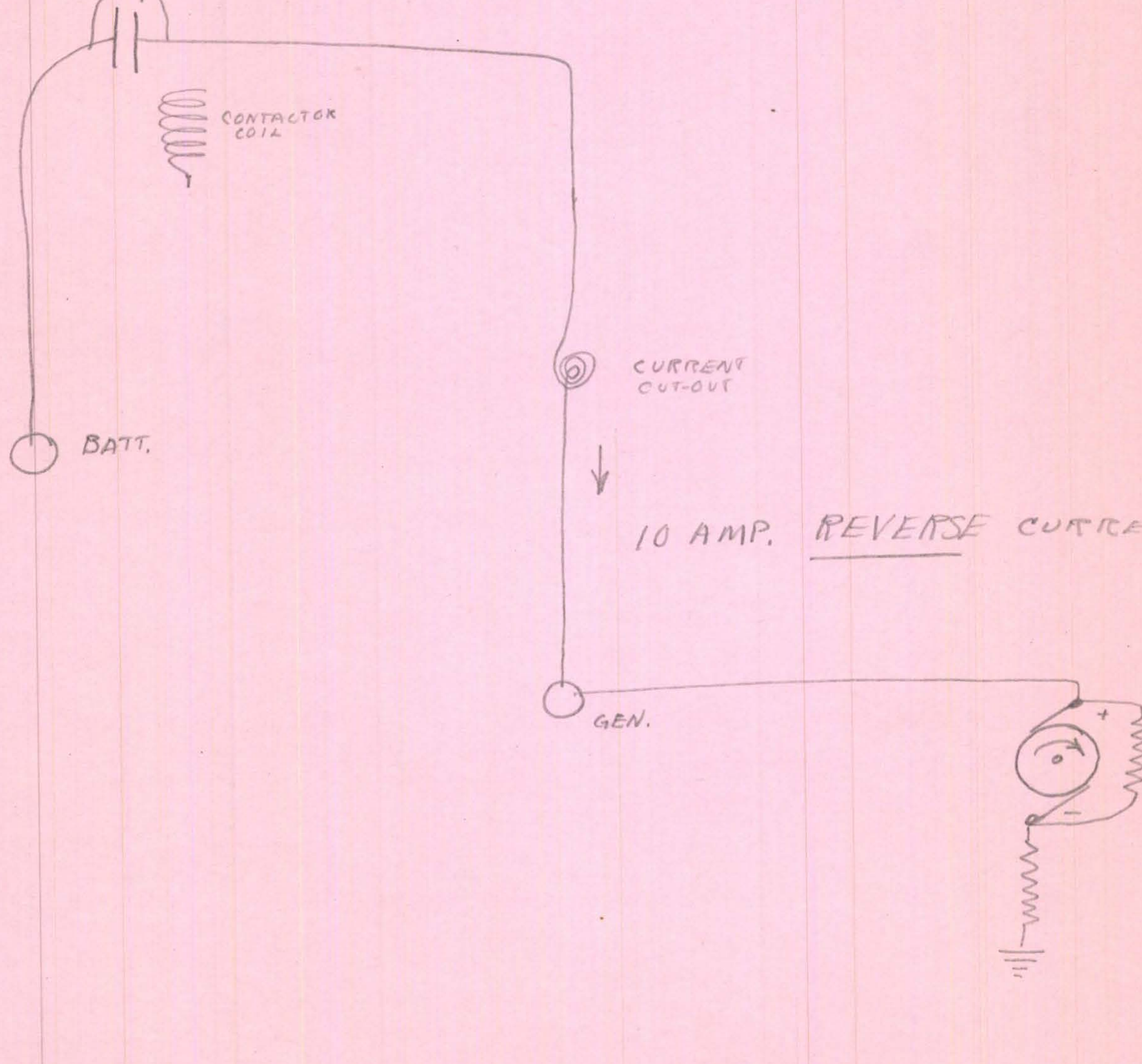
Propeller hub nuts
Exhaust flange stud nuts

E. Miscellaneous:

Check the breather screen for cleanliness every 100 hours.

If the engine is not to be run immediately, it is advisable to run the engine at part throttle on unleaded fuel as described in Chapter III for a period of 1/4 to 1/2 hour once or twice a week. If the engine is not run within one or two weeks it should be slushed following the procedure.

NOTE: Follow A.C. Technical Orders whenever a discrepancy exists between these instructions and the applicable Technical Order.


CONTACTOR COIL
CURRENT CUT-OUT
BATT.
10 AMP. REVERSE CURRENT
GEN.
+
-

so loaded, that the C.G. will be forward of the allowable. The same applies to personnel occupying the tail gunner's seat when the airplane is loaded to the most rearward C. G. allowable. On the B-25B the re-arrangement of the aft part of the airplane to include two turrets and no tail gun has moved the C. G. aft to such a position that it is essential that the table and notes be followed rigidly.

At the bottom of each chart is the inboard profile cut-away of the fuselage. The numbers in the circles represent stations of the airplane or distance from the nose of the airplane which is station 0. In the bomb bay section it will be noted that the forward and rearward C. G. allowable limits, twenty (20) to thirty-two (32) percent, are located by station number, namely Station 236 and 250. The ground line is graduated in increments of ten (10) inches to aid in distributing extra equipment or personnel in the airplane so as not to exceed the allowable C. G. range. The forward C. G. limits, station 236,is used as the 0 point for graduating the ground line forward and the rearward C. G. limit, Station 250, is the 0 point for graduating the ground line aft. For example, if the airplane was lightly loaded so that the C. G. approached the forward limit, Station 236,and one hundred (100) pounds of baggage or equipment were added and placed in the tunnel under the pilot, say at a distance of one hundred and twenty (120) inches forward of Station 236, an equivalent amount of ballast (or half of the baggage or equipment) should be placed a distance of one hundred and twenty (120) inches aft, or as indicated on the diagram, approximately at the radio seat.

In conclusion, the chart covers all conditions for which the airplane was designed, from light weight condition to maximum overload conditions, and should be followed rigidly in order to prevent operating personnel from overloading or placing items of freight, supplies, or personnel in such positions in the airplane that the C. G. or flying qualities are affected.

ITEMS	LOCATION	BALLAST OR ITEMS REQUIRED AT ALL TIMES		OTHER ITEMS OF USEFUL* LOAD-USE ANY COMBINATION		LOCATION OF BALLAST
		ITEMS (LBS.)	BALLAST (LBS.)	NORMAL (LBS.)	OVERLOAD (LBS.)	
CREW						
PILOT & PARACHUTE	PILOT'S SEAT	200	200			PILOT'S SEAT
CO-PILOT & PARACHUTE	CO-PILOT'S SEAT	200	200			CO-PILOT'S SEAT
BOMBARDIER & PARACHUTE	NAV. OR BOMBARD. SEAT	200	200			NAVIGATOR'S SEAT
RADIO OPERATOR & PARACHUTE	RADIO OPERATOR'S SEAT	200	200			RADIO OPERATOR'S SEAT
GUNNER & PARACHUTE	UPPER TURRET SEAT			200		
FUEL						
346 GAL. (NORMAL)	FRONT WING COMPTS.			2076		
88 GAL. (NORMAL)	REAR WING COMPTS.			528		
212 GAL. (OVERLOAD)	REAR WING COMPTS.				1272	
*418.6 GAL. (OVERLOAD)	BOMB BAY DROP. TANK				2512	
OIL						
39.4 GAL. (NORMAL)	WING COMPARTMENT	½ NORMAL OIL		295.5		
2.6 GAL. (PROP. FEATHER)	WING COMPARTMENT SUMP	20				
27.1 GAL. (OVERLOAD)	WING COMPARTMENT				203.2	
ARMAMENT						
.30 CAL. FLEX. GUN INSTALLATION	NOSE	80.8	80			BOMBARDIER'S RIDING SEAT
TOP TURRET INSTALLATION 2-.50 CAL. GUNS	TOP TURRET	128.0	100			UPPER TURRET AMMUN. BOXES
AMMUNITION (NORMAL-400 RDS.)	TOP TURRET			100	150	
BOTTOM TURRET INSTALLATION - 2-.50 CAL. GUNS	BOTTOM TURRET			128		
AMMUNITION (NORMAL-400 RDS.)	BOTTOM TURRET			100	100	
*4-600 LB. DEMOLITION BOMBS (NOR.)	BOMB BAY			2496		
*2-600 LB. DEMOLITION BOMBS (OVL.)	BOMB BAY				1248	
*MISCELLANEOUS BOMB SHACKLES	BOMB BAY			10.8	5.4	
MISCELLANEOUS EQUIPMENT						
PYROTECHNICS	TURRET COMPARTMENT			24.4		
T-3A PHOTOGRAPHIC EQUIPMENT	AFT OF REAR ENTRANCE			145.5		
*BOMB BAY FUEL TANK INSTALLATION	BOMB BAY				213.5	
ALTERNATE LOAD ITEMS						
5 - LIAISON SPARE COILS	RADIO COMPARTMENT				84.6	
2 - LIFE PRESERVER CUSHIONS	PILOT'S SEATS				7.0	
1 - LIFE RAFT	RADIO COMPARTMENT				52.0	
WEIGHT EMPTY ITEMS						
A.F.C. EQUIPMENT	BOMBARDIER'S COMPT.	122.7	120			BOMBARDIER'S RIDING SEAT
UPPER TURRET INSTALLATION	TURRET COMPARTMENT	402	400			TURRET COMPT. FLOOR
LOWER TURRET INSTALLATION	TURRET COMPARTMENT	397	400			TURRET COMPT. FLOOR

NOTES:

1. NORMAL HORIZONTAL C.G. (BOMBARDIER IN NAVIGATOR'S SEAT)
   - A. 27.31% M.A.C. (GEAR DOWN)
   - B. 29.41% M.A.C. (GEAR UP)
2. HORIZONTAL C.G. (ALLOWABLE RANGE)
   - A. MOST FORWARD C.G. - 20.0% M.A.C. (GEAR DOWN)
   - B. MOST REARWARD C.G. - 32.0% M.A.C. (GEAR UP)
3. MAXIMUM ALLOWABLE GROSS WEIGHT - 29,000 LBS.

*4. BOMB BAY TANK INSTALLATION AND OVERLOAD FUEL IN BOMB BAY TANK OR TOW TARGET GEAR MAY BE CARRIED IN PLACE OF BOMBS. ALTERNATE BOMB LOADS AS SHOWN ON BOMB CHARTS IN BOMB BAY MAY BE CARRIED IN PLACE OF 600 LB. BOMBS LISTED ABOVE.

5. A. SUPPLIES, MISCELLANEOUS EQUIPMENT, ETC., MAY BE CARRIED IN THE BOMB BAY ON A REMOVABLE PLATFORM, IN PLACE OF BOMBS OR OVERLOAD FUEL, WITHOUT POSSIBILITY OF EXCEEDING C.G. LIMITS. DO NOT EXCEED MAXIMUM USEFUL LOAD.

   B. IF EITHER THE A.F.C. EQUIPMENT OR NOSE FLEX. GUN INSTALLATION OR THEIR BALLAST OR BOTH ARE REMOVED, AN EQUIVALENT AMOUNT OF SUPPLIES, MISCL. EQUIPMENT OR BALLAST SHOULD BE PLACED IN THE BOMBARDIER'S COMPT.

   C. MISCELLANEOUS EQUIPMENT, SUPPLIES, ETC. IN PLACE OF OR EXCEEDING NORMAL EQUIPMENT LISTED IN THE CHART ABOVE, SHOULD NOT BE CARRIED ON THE OBSERVER'S FLOOR OR ANY OTHER LOCATION IN THE AFT COMPT. OF THE AIRPLANE DUE TO LACK OF NECESSARY SPACE AND TIE-DOWN FACILITIES TO KEEP THE C.G. WITHIN THE ALLOWABLE RANGE.

6. **WARNING:**

   A. WHEN THE AIRPLANE IS BALLASTED OR LOADED TO THE MAXIMUM GROSS WEIGHT, THE C.G. OF THE AIRPLANE WILL BE AFT OF THE MOST REARWARD ALLOWABLE WITH BOMBARDIER IN NAVIGATOR'S SEAT. WHEN THE BOMBARDIER IS IN HIS FLIGHT STATION, THE LOCATION OF THE C.G. WILL BE APPROXIMATELY AT THE MOST REARWARD ALLOWABLE. THE MAXIMUM GROSS WEIGHT CONSISTS OF A CREW OF FIVE, 646 GAL. FUEL, 43 GAL. OIL, ONE .30 CAL. FLEX. NOSE GUN INSTALLATION, FOUR .50 CAL. TURRET GUN INSTALLATIONS, MAXIMUM .50 CAL. AMMUNITION, SIX -600 LB. DEMOLITION BOMBS AND SHACKLES, PYROTECHNICS, PHOTOGRAPHIC EQUIPMENT, FIVE LIAISON SPARE COILS, TWO LIFE PRESERVER CUSHIONS, AND ONE LIFE RAFT.

   B. THE BOMBARDIER'S SEAT SHOULD NOT BE OCCUPIED BY PERSONNEL WHEN THE AIRPLANE IS LOADED TO MOST FORWARD C.G. (20.0% M.A.C.). ALSO, THE OBSERVER'S STATION IN THE TAIL END, AND/OR THE PHOTOGRAPHIC SEAT SHOULD NOT BE OCCUPIED BY PERSONNEL WHEN THE AIRPLANE IS LOADED TO THE MOST REARWARD C.G. (MAXIMUM GROSS WEIGHT).

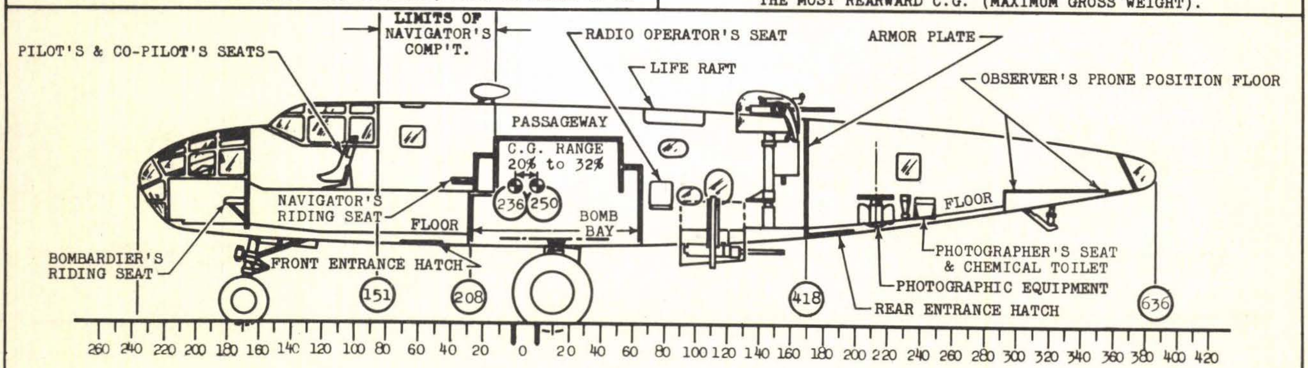


FIG. 2 AIRPLANE LOADING CHART (B-25B)

AIR CORPS SERIAL NOS. AC40-2229 TO AC40-2348 INCL. (65TH TO 184TH AIRPLANES)

ITEMS	LOCATION	BALLAST OR ITEMS REQUIRED AT ALL TIMES: ITEMS (LBS)	BALLAST OR ITEMS REQUIRED AT ALL TIMES: BALLAST (LBS)	OTHER ITEMS OF USEFUL LOAD USE ANY COMBINATION: NORMAL (LBS)	OTHER ITEMS OF USEFUL LOAD USE ANY COMBINATION: OVERLOAD (LBS)	LOCATION OF BALLAST
CREW						
PILOT & PARACHUTE	PILOT'S SEAT	200	200			PILOT'S SEAT
CO-PILOT & PARACHUTE	CO-PILOT'S SEAT	200	200			CO-PILOT'S SFAT
BOMBARDIER & PARACHUTE	NAVIGATOR'S OR BOMBARDIER'S SEAT			200		
RADIO OPERATOR & PARACHUTE	RADIO OPERATOR'S SEAT	200	200			RADIO OPFRATOR'S SEAT
GUNNER & PARACHUTE	ANY WAIST GUNNER'S SEAT	200	200			ANY WAIST GUNNER'S SEAT
FUEL						
346 GAL. (NORMAL)	FRONT WING COMPARTMENTS			2076		
88 GAL. (NORMAL)	REAR WING COMPARTMENTS			528		
212 GAL. (OVERLOAD)	REAR WING COMPARTMENTS				1272	
*418.6 GAL. (OVERLOAD)	BOMB BAY DROPPABLE TANK				2512	
OIL						
39.4 GAL. (NORMAL)	WING COMPARTMENT	1/2 NORMAL OIL		295.5		
2.6 GAL. (PROP. FEATHERING)	WING COMPARTMENT SUMP	20				
27.1 GAL. (OVERLOAD)	WING COMPARTMENT				203.3	
ARMAMENT						
**.30 CAL. FLEXIBLE GUN INSTALLATION	NOSE	80.7	80			BOMBARDIER'S RIDING SFAT
**.30 CAL FLEXIBLE GUN INSTALLATION	TOP WAIST	80.93	80			ANY WAIST GUNNFR'S SEAT
**.30 CAL. FLEXIBLE GUN INSTALLATION	SIDE & BOTTOM	83.10	85			ANY WAIST GUNNFR'S SFAT
**.50 CAL. FLEXIBLF GUN INSTALLATION	TAIL	159.11	160			TAIL GUNNFR'S SEAT
*4-600 LB. DEMOLITION BOMBS (NORMAL)	BOMB BAY			2496		
*2-600 LB. DEMOLITION BOMBS (OVERLOAD)	BOMB BAY				1248	
*MISCELLANEOUS BOMB SHACKLES	BOMB BAY			10.8	5.4	
MISCELLANEOUS EQUIPMENT						
PYROTECHNICS	WAIST GUN COMPARTMENT			24.36		
T-3A PHOTOGRAPHIC EQUIPMENT	RADIO COMPARTMENT			145.5		
*BOMB BAY TANK INSTALLATION	BOMB BAY				213.5	
ALTERNATE LOAD ITEMS						
5 - LIAISON SPARE COILS	RADIO COMPARTMENT				84.6	
2 - LIFE PRESERVER CUSHIONS	PILOTS' SEATS				7.0	
1 - LIFE RAFT	RADIO COMPARTMENT				52.0	
WEIGHT EMPTY ITEMS						
** A.F.C. EQUIPMENT	BOMBARDIER'S COMPARTMENT	122.7	120			BOMBARDIER'S RIDING SFAT

NOTE

1. NORMAL HORIZONTAL C.G. (BOMBARDIER IN NAVIGATOR'S SEAT)
   - A. 26.96 % M.A.C. (GEAR DOWN)
   - B. 29.13 % M.A.C. (GEAR UP)
2. HORIZONTAL C.G. (ALLOWABLE RANGF)
   - A. MOST FORWARD C.G. 20.0 % M.A.C. (GEAR DOWN)
   - B. MOST REARWARD C.G. 32.0 % M.A.C. (GEAR UP)

* 3. BOMB BAY TANK INSTALLATION AND OVERLOAD FUEL IN BOMB BAY TANK MAY BE CARRIED IN PLACE OF BOMBS. ALTERNATE BOMB LOADS AS SHOWN ON BOMB CHARTS IN BOMB BAY MAY BE CARRIED IN PLACE OF 600 LB. BOMBS LISTED ABOVE.

** 4. A. **WHEN ALL OF THE REAR FLEXIBLE GUN INSTALLATIONS OR THEIR BALLASTS ARE REMOVED, AN EQUAL AMOUNT, OR NOT MORE THAN 450 LBS. OF MISCELLANEOUS EQUIPMENT, SUPPLIES, PERSONNEL OR BALLAST SHOULD BE SUBSTITUTED AND DISTRIBUTED IN THE WAIST GUN COMPARTMENT.**

B. IF EITHER THE A.F.C. EQUIPMENT OR NOSE FLEXIBLE GUN INSTALLATION OR THEIR BALLAST OR BOTH ARE REMOVED. AN EQUIVALENT AMOUNT OF SUPPLIES, MISCELLANEOUS EQUIPMENT OR BALLAST SHOULD BE PLACED IN THE BOMBARDIER'S COMPARTMENT.

5. EXTRA SUPPLIES, MISCELLANEOUS EQUIPMENT, ETC., OVER AND ABOVE ITEMS LISTED IN PARAGRAPH 4., MAY BF CARRIED IN THE BOMB BAY ON A RFMOVABLE PLATFORM, IN PLACE OF BOMBS OR OVERLOAD FUEL, WITHOUT POSSIBILITY OF EXCEEDING C.G. LIMITS. DO NOT EXCEED MAXIMUM USEFUL LOAD.

6. **WARNING**
   - A. IF ONE EXTRA .30 CAL. FLEXIBLE GUN INSTALLATION IN THF SIDE GUN WINDOW AND TWO EXTRA GUNNERS ARE ADDED IN THE WAIST GUN COMPARTMENT, WHEN THE AIRPLANE IS BALLASTED OR LOADED TO THF MAXIMUM GROSS WEIGHT, THE C.G. OF THE AIRPLANE WILL BF AFT OF THF MOST REARWARD ALLOWABLE C.G. THE MAXIMUM GROSS WEIGHT CONSISTS OF A CREW OF FIVE, 646 GAL. FUEL, 43 GAL. OIL, THRFE .30 CAL. FLEXIBLE GUN INSTALLATIONS, ONE .50 CAL. FLEXIBLF TAIL GUN INSTALLATION, SIX - 600 LB. DEMOLITION BOMBS AND SHACKLES, PYROTFCHNICS, PHOTOGRAPHIC EQUIPMENT, FIVE LIAISON SPARE COILS, TWO LIFE PRESERVFR CUSHIONS, AND ONE LIFE RAFT.
   - B. BOMBARDIER'S SEAT SHOULD NOT BE OCCUPIED BY PFRSONNEL WHEN THE AIRPLANE IS LOADED TO MOST FORWARD C.G. (20.0% M.A.C.). ALSO, THE TAIL GUNNER'S SEAT SHOULD NOT BE OCCUPIFD BY PFRSONNEL WHEN THE AIRPLANE IS LOADED TO MOST REARWARD C.G. (32.0% M.A.C.).

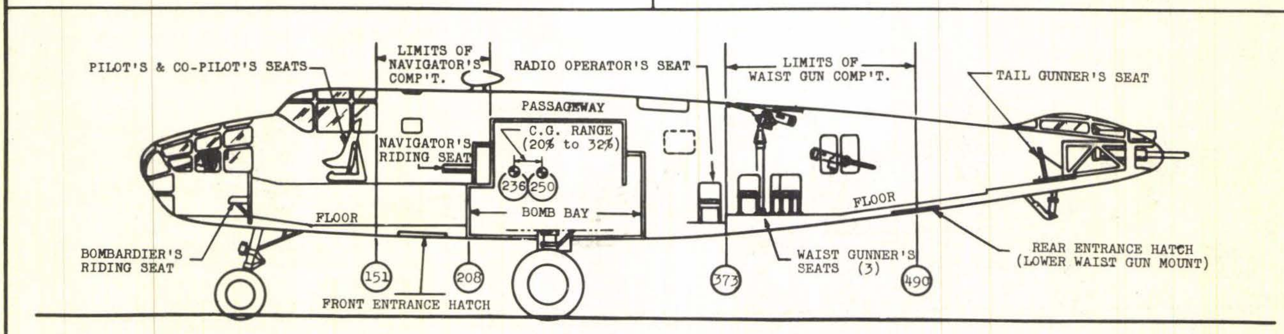


FIG. 3 AIRPLANE LOADING CHART (B-25A)

AIR CORPS SERIAL NOS. AC40-2189 TO AC40-2228 INCL. (25TH TO 64TH AIRPLANES)

ITEMS	LOCATION	BALLAST OR ITEMS REQUIRED AT ALL TIMES		OTHER ITEMS OF USEFUL LOAD USE ANY COMBINATION		LOCATION OF BALLAST
		ITEMS (LBS.)	BALLAST (LBS.)	NORMAL (LBS.)	OVERLOAD (LBS)	
CREW						
PILOT & PARACHUTE	PILOT'S SEAT	200	200			PILOT'S SEAT
CO-PILOT & PARACHUTE	CO-PILOT'S SEAT	200	200			CO-PILOT'S SEAT
BOMBARDIER & PARACHUTE	NAVIGATOR'S OR BOMBARDIER'S SEAT			200		
RADIO OPERATOR & PARACHUTE	RADIO OPERATOR'S SEAT	200	200			RADIO OPERATOR'S SEAT
GUNNER & PARACHUTE	ANY WAIST GUNNER'S SEAT	200	200			ANY WAIST GUNNER'S SEAT
FUEL						
434 GAL. (NORMAL)	FRONT WING COMPARTMENTS	RESERVE FUEL		2604		
49 GAL. (OVERLOAD)	FRONT WING COMPARTMENTS				294	
433 GAL. (OVERLOAD)	REAR WING COMPARTMENTS				2598	
*418.6 GAL. (OVERLOAD)	BOMB BAY DROPPABLE TANK				2512	
OIL						
39.4 GAL. (NORMAL)	WING COMPARTMENT	1/2 NORMAL OIL		295.5		
2.6 GAL. (PROP. FEATHER)	WING COMPARTMENT SUMP	20				
44.0 GAL. (OVERLOAD)	WING COMPARTMENT				330	
ARMAMENT						
.30 CAL. FLEXIBLE GUN INSTALLATION	NOSE			80.3		
**.30 CAL. FLEXIBLE GUN INSTALLATION	TOP WAIST	80.63	80			ANY WAIST GUNNER'S SEAT
**.30 CAL. FLEXIBLE GUN INSTALLATION	SIDE & BOTTOM	82.80	85			ANY WAIST GUNNER'S SEAT
**.50 CAL. FLEXIBLE GUN INSTALLATION	TAIL	159.11	160			TAIL GUNNER'S SEAT
*4-600 LB. DEMOLITION BOMBS (NORMAL)	BOMB BAY			2496		
*2-600 LB. DEMOLITION BOMBS (OVERLOAD)	BOMB BAY				1248	
*MISCELLANEOUS BOMB SHACKLES	BOMB BAY			10.8	5.4	
MISCELLANEOUS EQUIPMENT						
PYROTECHNICS	WAIST GUN COMPARTMENT			24.36		
T-3A PHOTOGRAPHIC EQUIPMENT	RADIO COMPARTMENT			145.5		
*BOMB BAY TANK INSTALLATION	BOMB BAY				213.5	
ALTERNATE LOAD ITEMS						
5 - LIAISON SPARE COILS	RADIO COMPARTMENT				84.6	
2 - LIFE PRESERVER CUSHIONS	PILOTS' SEATS				7.0	
1 - LIFE RAFT	RADIO COMPARTMENT				52.0	
WEIGHT EMPTY ITEMS						
A.F.C. EQUIPMENT	BOMBARDIER'S COMPARTMENT	122.7	120			BOMBARDIER'S RIDING SEAT

NOTE

1. NORMAL HORIZONTAL C.G. (BOMBARDIER IN NAVIGATOR'S SEAT)

A. 23.8% M.A.C. (GEAR DOWN)
B. 26.1% M.A.C. (GEAR UP)

2. HORIZONTAL C.G. (ALLOWABLE RANGE)

A. MOST FORWARD C.G. 20.0% M.A.C. (GEAR DOWN)
B. MOST REARWARD C.G. 32.0% M.A.C. (GEAR UP)

***3.** BOMB BAY TANK INSTALLATION AND OVERLOAD FUEL IN BOMB BAY TANK MAY BE CARRIED IN PLACE OF BOMBS. ALTERNATE BOMB LOADS, AS SHOWN ON BOMB CHARTS IN BOMB BAY, MAY BE CARRIED IN PLACE OF 600 LB. BOMBS LISTED ABOVE.

****4. A.** WHEN THE TWO REAR .30 CAL. FLEXIBLE GUN INSTALLATIONS AND ONE .50 CAL. FLEXIBLE TAIL GUN INSTALLATION OR THEIR BALLASTS ARE REMOVED, 500 LBS. OF MISCELLANEOUS EQUIPMENT, SUPPLIES, CREW MEMBERS OR BALLAST, SHOULD BE SUBSTITUTED AND DISTRIBUTED IN THE WAIST GUN COMPARTMENT.

B. IF ONE OR BOTH OF THE .30 CAL. GUN INSTALLATIONS OR THEIR BALLASTS ARE REMOVED, AN EQUAL AMOUNT OF EQUIPMENT OR SUPPLIES SHOULD BE SUBSTITUTED, AND PLACED IN THE WAIST GUN COMPARTMENT. IF ONLY THE TAIL GUN INSTALLATION OR ITS BALLAST IS REMOVED, 350 LBS. OF PERSONNEL, EQUIPMENT OR SUPPLIES SHOULD BE SUBSTITUTED AND PLACED IN THE WAIST GUN COMPARTMENT.

5. EXTRA SUPPLIES, MISCELLANEOUS EQUIPMENT, ETC., OVER AND ABOVE ITEMS LISTED IN PRECEDING PARAGRAPH 4., MAY BE CARRIED IN THE BOMB BAY ON A REMOVABLE PLATFORM, IN PLACE OF BOMBS OR OVERLOAD FUEL WITHOUT POSSIBILITY OF EXCEEDING C.G. LIMITS. DO NOT EXCEED MAXIMUM USEFUL LOAD.

6. WARNING

A. IF ONE EXTRA .30 CAL. FLEXIBLE GUN INSTALLATION IN THE SIDE GUN WINDOW AND TWO EXTRA GUNNERS ARE ADDED IN THE WAIST GUN COMPARTMENT, WHEN THE AIRPLANE IS BALLASTED OR LOADED TO THE MAXIMUM GROSS WEIGHT, THE C.G. OF THE AIRPLANE WILL BE AFT OF THE MOST REARWARD ALLOWABLE C.G. THE MAXIMUM GROSS WEIGHT CONSISTS OF A CREW OF FIVE, 916 GALLONS FUEL, 59.9 GALLONS OIL, THREE .30 CAL. FLEXIBLE GUN INSTALLATIONS, ONE .50 CAL. FLEXIBLE TAIL GUN INSTALLATION, SIX - 600 LB. DEMOLITION BOMBS AND SHACKLES, PYROTECHNICS, PHOTOGRAPHIC EQUIPMENT, FIVE LIAISON SPARE COILS. TWO LIFE PRESERVER CUSHIONS, AND ONE LIFE RAFT.

B. BOMBARDIER'S SEAT SHOULD NOT BE OCCUPIED BY PERSONNEL WHEN THE AIRPLANE IS LOADED TO MOST FORWARD C.G. (20.0% M.A.C.). ALSO, THE TAIL GUNNER'S SEAT SHOULD NOT BE OCCUPIED BY PERSONNEL WHEN THE AIRPLANE IS LOADED TO MOST REARWARD C.G. (32.0% M.A.C.).

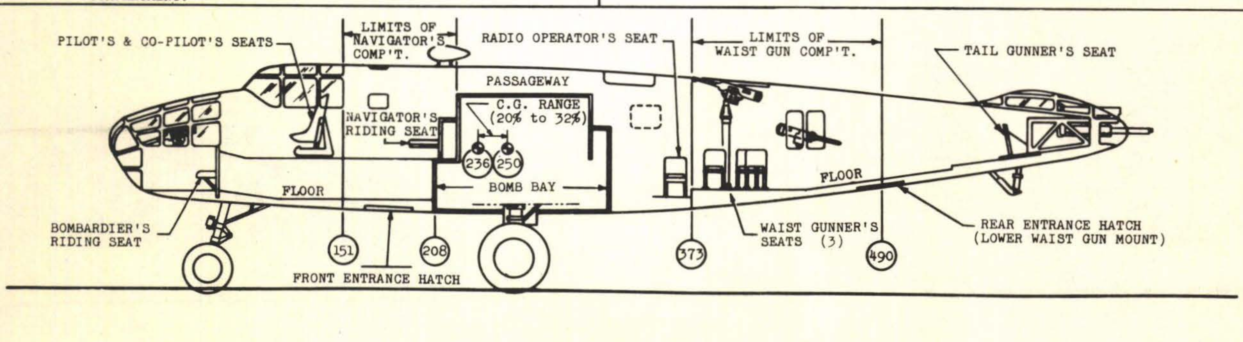


FIG. 4 AIRPLANE LOADING CHART (B-25)

AIR CORPS SERIAL NOS. AC40-2165 TO AC40-2188 INCL. (1ST TO 24TH AIRPLANES)

STRUCTURES

RADIO
INSTALLATION

NORTH AMERICAN AVIATION Inc.

Radio Install.
LECTURE
B-25 SERIES AIRPLANES

PREPARED BY Leavitt B Glaze

NOTE

THE INFORMATION CONTAINED IN THIS LECTURE WAS CORRECT AS OF MAY 15, 1942. REFER TO HANDBOOK OF OPERATION AND SERVICE INSTRUCTIONS FOR THE LATEST INFORMATION.

INGLEWOOD, CALIFORNIA

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ILLUSTRATIONS

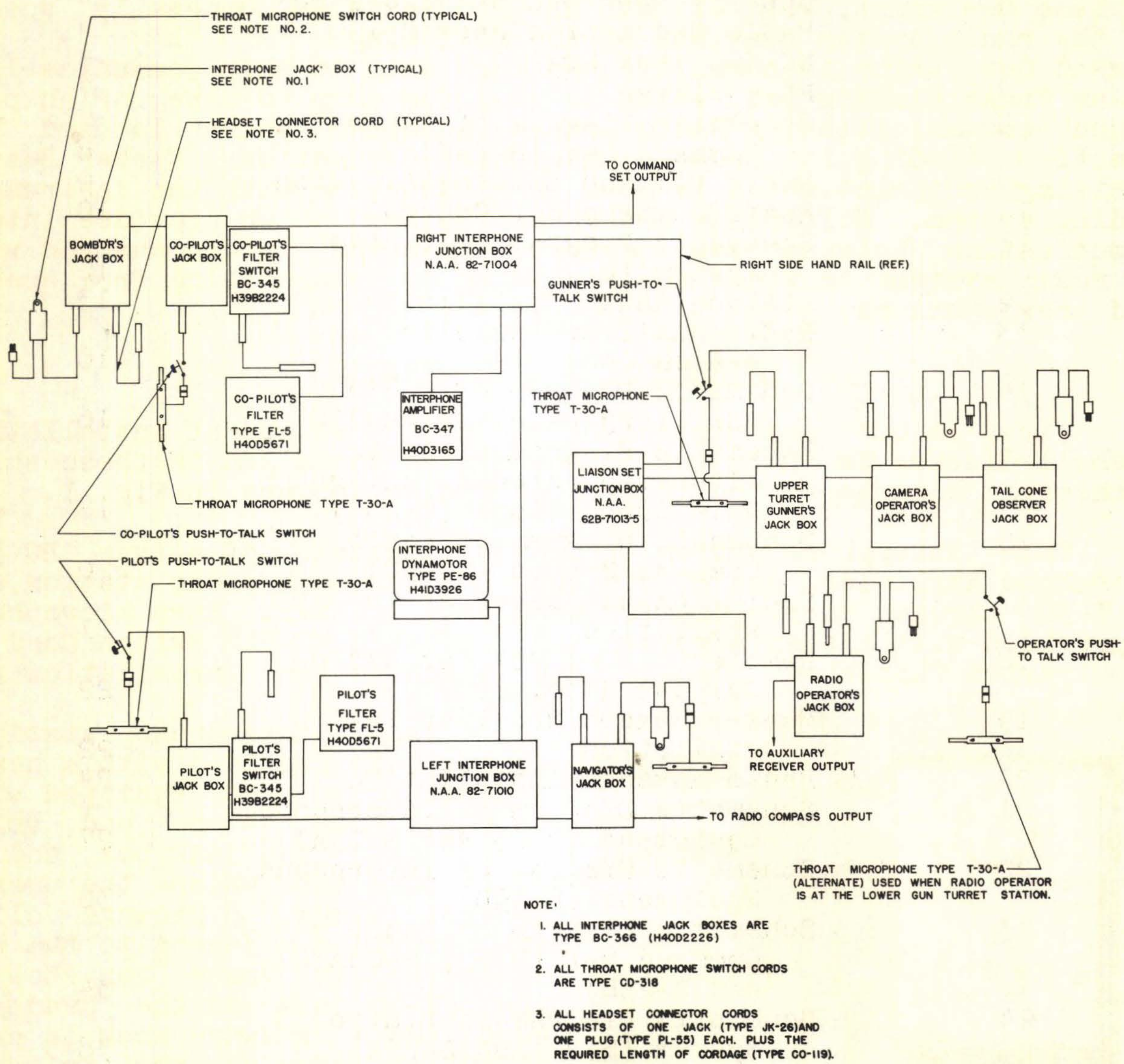


FIG. 1 SCHEMATIC DIAGRAM OF INTERPHONE EQUIPMENT (B-25C)

GENERAL

This lecture deals with the radio installation in Model B-25C airplanes with addendum covering Models B-25, B-25A and B-25B. All radio equipment installed in B-25C airplanes is primarily operable from 24-volt D.C. current supply, while radio equipment installed in B-25, B-25A and B-25B models operates from 12-volt D.C. current supply. Primarily these installations consist of radio equipment for bombardment airplanes as outlined in the Handbook of Instructions for Airplane Designers, Vol. II, 8th Ed. 2nd Revision. Generally speaking the radio system consists of the following:
Command Set, which is normally used for ship to ship communication. Medium Range Liaison Set, which is used for ship to base, or ship to ground communication. A Radio Compass Receiver, which is used for direction finding in cross-country air navigation. Marker Beacon Receiving Equipment, which is used in conjunction with the instrument landing system. Multiplace Interphone System, which provides intercommunication between crew members, and being interconnected with the radio systems, provides for receiving or transmitting from specified crew stations.

INTERPHONE SYSTEM GENERAL

First in our description of the radio equipment installation we shall discuss the RC-36 interphone system installed in these ships. A schematic diagram of the interphone system appears in Fig. 1.

This interphone system primarily consists of a type BC-347 Interphone Amplifier, one BC-366 Jack Box for each phone station, and one T-30 throat microphone for each crew member. Each microphone is provided with either a government furnished CD-318 Switch Cord or a contractor furnished push-to-talk switch as the installation requires.

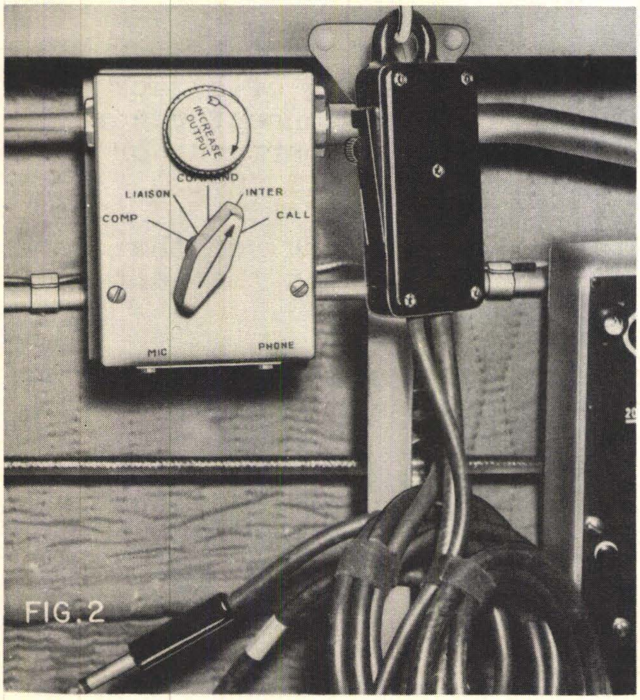


FIG. 2

Each interphone station (Fig. 2) is provided with a headset connector cord equipped with a PL-55 plug at one end, which plugs into the jack box, and a JK-26 jack into which the user's headset plugs. Stowage clips are provided adjacent to the respective jack boxes for stowing the JK-26 jack of the headset cord, and a stowage hook is provided for stowing the switchof the microphone switching cord while not in use.

No interphone power supply being available from the command set installed in these ships, a separate interphone power supply is necessary. To furnish this independent power supply for the

interphone system a PE-86 dynamotor has been installed on the floor of the pilot's compartment immediately aft and to the outboard side of the pilot's seat.

In order to talk into the interphone system, the use of a press-to-talk switch is necessary in conjunction with the microphone. This switch is built into and forms a part of CD-318 switch cord. These switch cords have been installed at all interphone stations except pilot's, co-pilot's and upper turret gunner's.

The pilot's and co-pilot's interphone stations (Fig. 3) are located on the left and right sides of the ship, respectively, adjacent to the aileron control wheel and consist of a jack box and throat microphone with the addition of a type BC-345 switch box and a type FL-5 filter for each station.

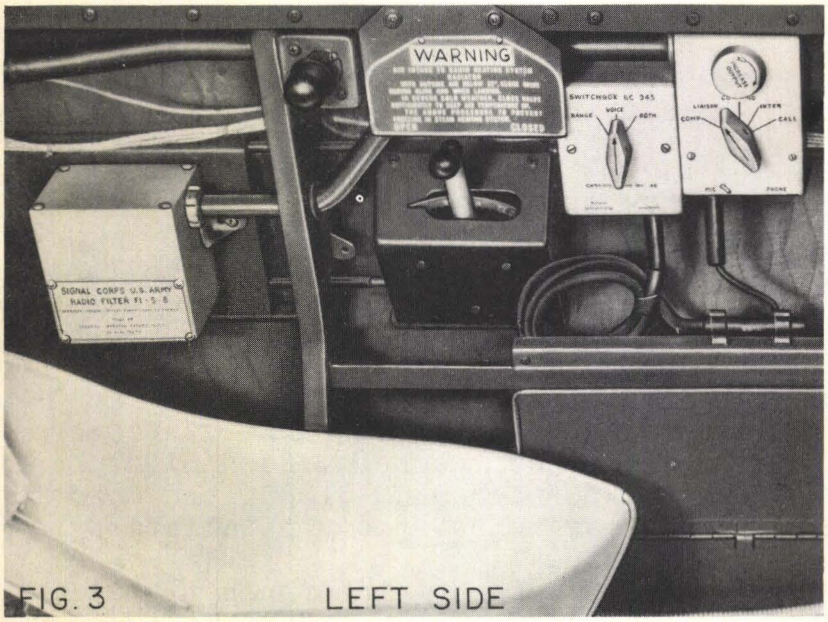
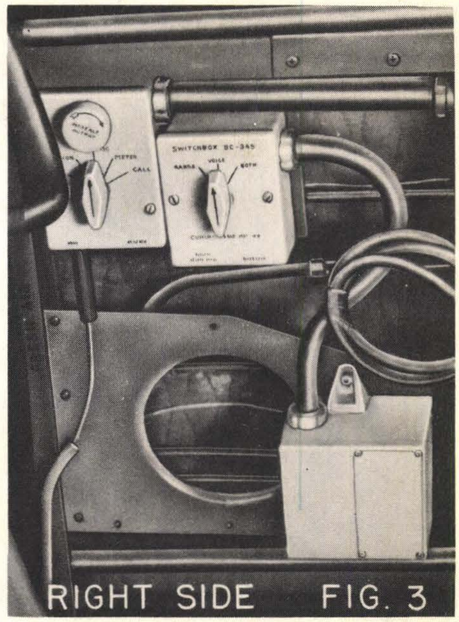


FIG. 3 LEFT SIDE



RIGHT SIDE FIG. 3

The bombardier's interphone station, consisting of a jack box, a throat microphone with switch cord and headset connector cord, is located on the right side of the bombardier's compartment or nose section of the ship.

The navigator's interphone station, consisting of the same equipment, is located in the navigator's compartment on the left side of the airplane just below the window.

The radio and lower turret operator's interphone station consisting of the same equipment, is located on a supporting member immediately aft and below the liaison receiver.

The camera operator's interphone station consists of the same equipment and is located on the left side of the ship adjacent to the camera.

The tail observer's interphone station, consisting of the same equipment, is located in the tail section of the airplane.

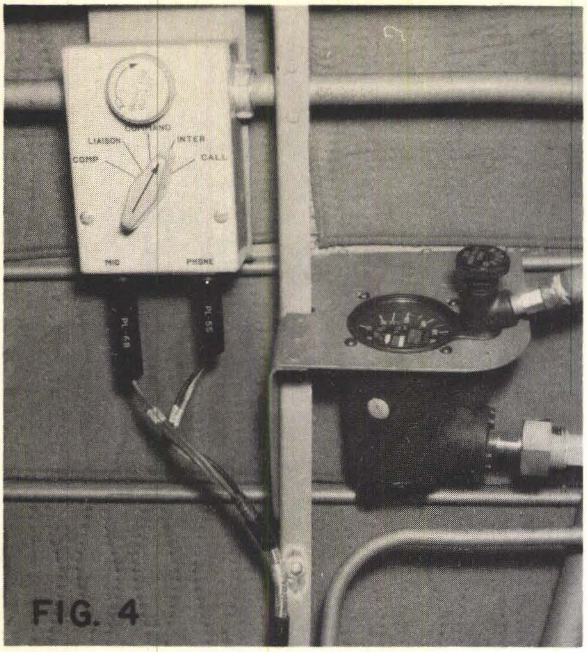


FIG. 4

The upper turret gunner's interphone jack box (Fig. 4) is located on the left side of the airplane, just below the upper longeron. Connected to plugs PL-55 and PL-68 at the jack box is a four-conductor shielded cable which extends downward, terminating in an AN-3106 plug located on the upper turret junction box. The microphone and headset circuits are carried from slip rings in the base of the turret up through the column to a press-to-talk push-button switch which is provided by the turret manufacturer and is located on the left side of the turret. The gunner's throat microphone extension cord and head set extension cord connect his T-30 throat microphone and headset respectively to a four-post terminal block, furnished by the turret manufacturer and located within the turret mechanism housing.

The radio operator, in addition to operating the liaison radio set, acts as gunner and operates the lower turret guns. For his use of the interphone system a jack box has been located on a supporting

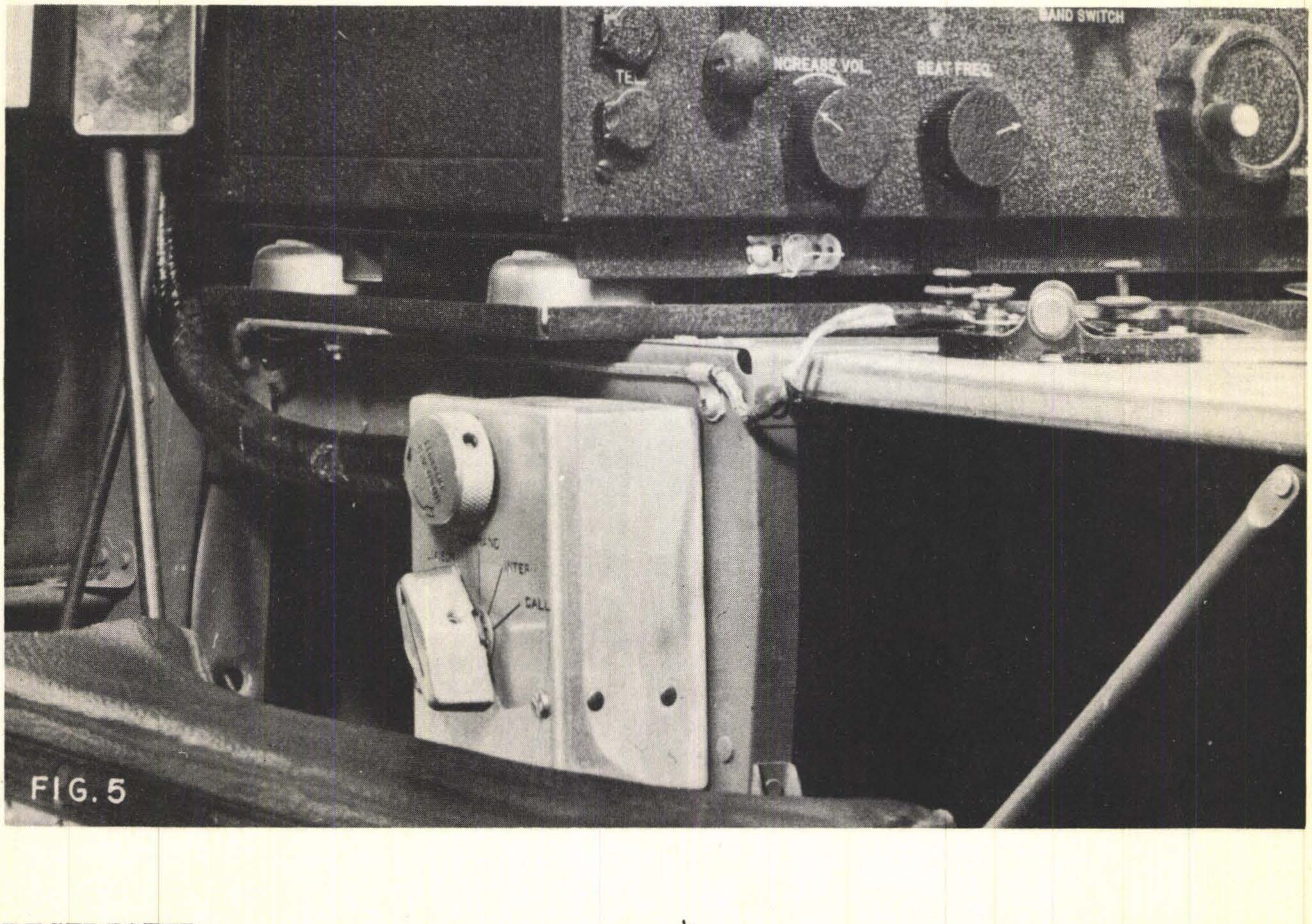


FIG. 5

member immediately aft of the liaison receiver. A T-30 throat microphone is provided for the radio operator's use and while acting as lower turret gunner, is connected to the jack box through a push-button switch located in the left-hand control handle of the turret. A microphone switch cord is provided for the radio operator's use while operating the liaison equipment.

Amplification being required for a multiplace interphone system a type BC-347 interphone amplifier has been installed on the floor of pilot's compartment immediately aft of the co-pilot's seat.

INTERPHONE SYSTEM OPERATION

The interphone system derives its power from a separate dynamotor which operates independently of other radio equipment, and connects to the ship's power through the battery disconnect switches. The interphone dynamotor is running and the interphone system is operable when either cr both of the battery disconnect switches are in the "ON" position.

The interphone jack box (Fig. 6) of which there are eight in the ship, has five selective positions which are marked on the face of the box as follows, and with which it is possible to accomplish the following:

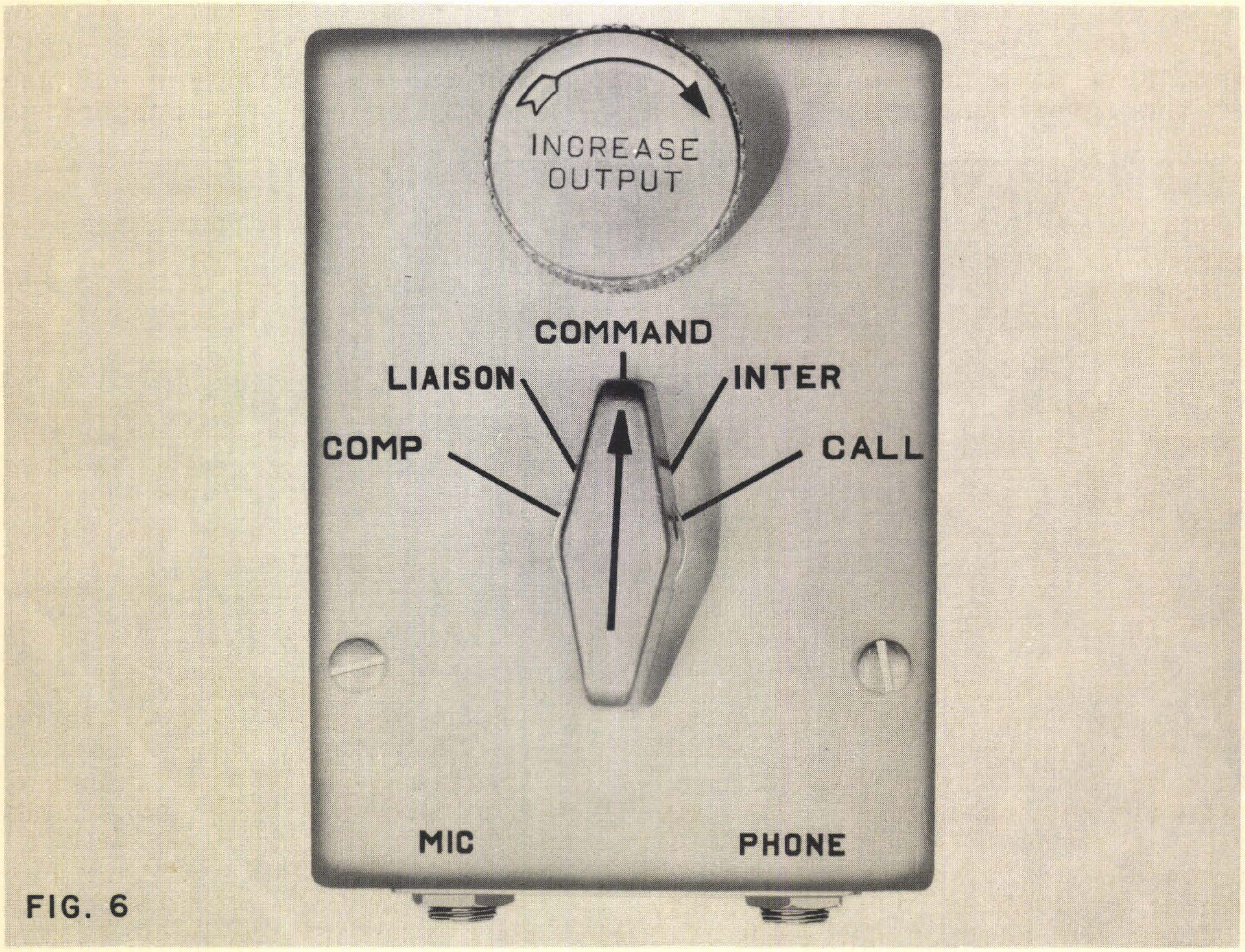


FIG. 6

Position 1, marked "COMPASS". In this position the audio output of the compass receiver only will be heard. A limited control over the headset volume can be had by manipulating the volume control. The microphone circuit is inoperative. This position is effective on all interphone stations.

Position 2, marked "LIAISON". In this position the liaison receiver output and the sidetone of the liaison transmitter will be heard. A limited control over the headset volume may be had by varying the volume control. The microphone push-to-talk switch operates the transmit-receive relay located within the liaison transmitter. The microphone will modulate the liaison transmitter when the switch is closed, and transmitter is in "voice" position.

Voice Transmission from this jack box position is effective only on the pilot's, co-pilot's and radio operator's interphone stations,since it is undesirable to have other crew members modulate or transmit voice over the liaison transmitter.

Position 3, marked "COMMAND". In this position the command receiver output and sidetone of the command transmitter will be heard. A limited control over the volume can be had by varying the volume control. The microphone push-to-talk switch operates the command transmit-receive relays which are located in the command radio receiver rack. The microphone will modulate the command transmitter when the push-to-talk switch is closed and the transmitter is in "voice" position. This position is effective on all interphone stations.

Position 4, marked "INTER". All jack boxes turned to this position provide an intercommunicating system for use between crew members. The microphone connects to the input of the interphone amplifier and the headphones to the output of this amplifier. The volume control is not effective in this position. This position is effective on all interphone stations.

Position 5, marked "CALL". This is an emergency call position in which all of the positions in all boxes are placed in parallel across the output of the interphone amplifier. In other words, should an emergency arise in which a crew member wishes to call an interphone station which may be in use, he may do so by switching his jack box to this call position. The microphone in this position is connected into the input of the interphone amplifier. This position is effective on all interphone stations.

You are probably all familiar with the simultaneous range set-up or the broadcasting of weather reports at periodic intervals on the same frequency as the beacon signal. The FL-5 filter (Fig. 7) is a device used for separating the voice giving the weather reports, from the beacon signal. The BC-345 switch box is a selector switch used in connection with the filter, and permits the pilot to select a combination of beacon signal only, beacon signal and weather reports or weather reports only. The selection is accomplished by turning the knob on the face of BC-345 switch box to the desired mar-

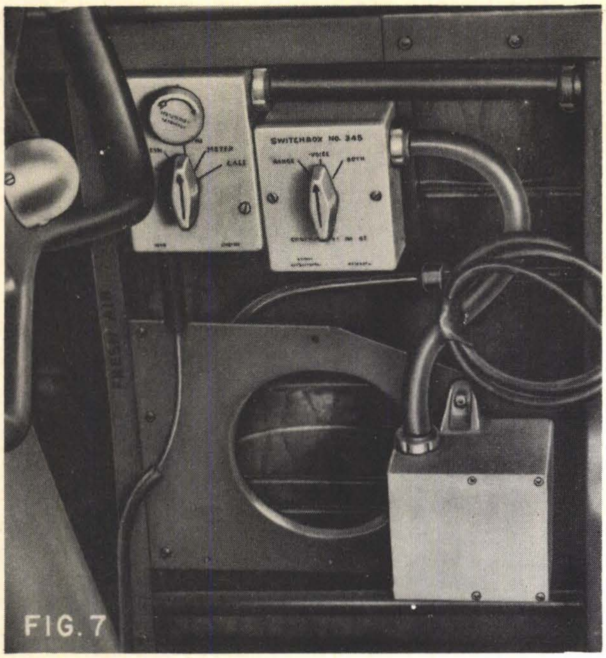


FIG. 7

king: Voice, Range or both. These devices identified as RC-32 filter equipment are provided for the pilot and co-pilot only.

The output of the pilot's throat microphone is connected to the interphone system through push-button switches on the pilot's and co-pilot's wheel. These push-button switches are functionally identical to the push-to-talk switch buttons on microphone switch cords and when depressed, the output of the microphone is connected to the interphone system.

COMMAND SET GENERAL

We will now discuss the command set which is identified as SCR-274-N and primarily consists of 2 transmitters and 3 receivers with remote control boxes for each group and an antenna switching relay for switching the antenna from the receive to the transmit, plus the necessary terminal or junction box. A schematic diagram of the command set appears in Fig. 8.

The two transmitters, Fig. 9, BC-457-A and BC-459-A are mounted in an FT-226-A rack which is secured to an FT-227-A mounting. The three receivers, BC-453-A, BC-454-A and BC-455-A are mounted in an FT-220-A rack which is secured to an FT-221-A mounting. The BC-456-A modulator is secured to an FT-225-A mounting while the BC-442-A antenna switching relay is secured to an FT-229-A mounting. The entire group of command set units is mounted on shelves or brackets located in the upper right side of the navigator's compartment.

The command set is a short-range radio communication system, and as stated before is used primarily for ship to ship communication in the following channels. The BC-457-A transmitter has a frequency range of 4000 to 5300 KC and the BC-459-A has a frequency range of 7000 to 9100 KC. The BC-453-A, BC-454-A and BC-455-A receivers cover frequency ranges of 190 to 550, 3000 to 6000 and 6000 to 9100 KC respectively. There are no spare coils required for either command transmitters or receivers.

Each transmitter is supplied with a special frequency-checking circuit and a plug-in crystal resonator. This plug-in crystal and crystal circuit is used for checking the transmitter frequency at a definite point on the dial and does NOT control the frequency being transmitted.

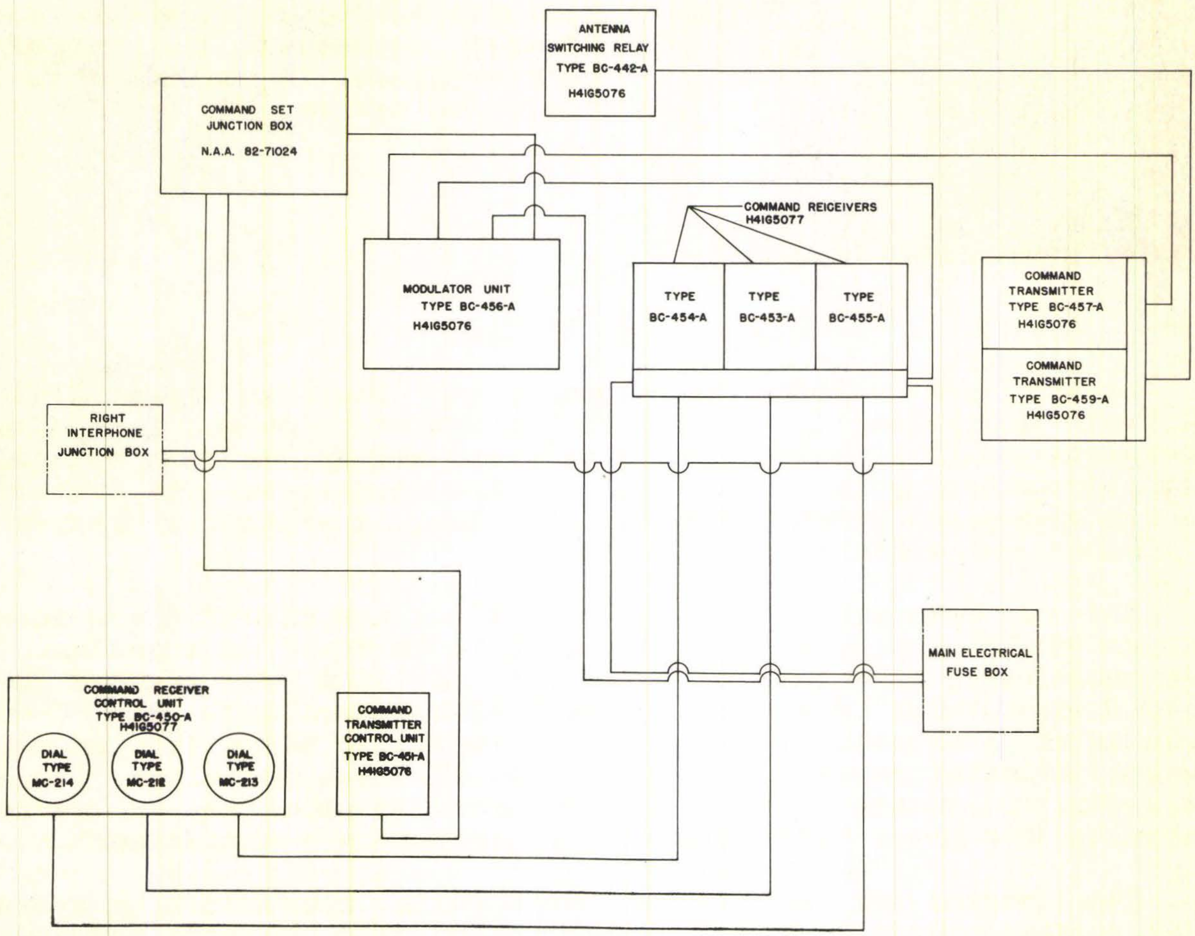


FIG. 8 SCHEMATIC DIAGRAM OF RADIO COMMAND SET (B-25C)

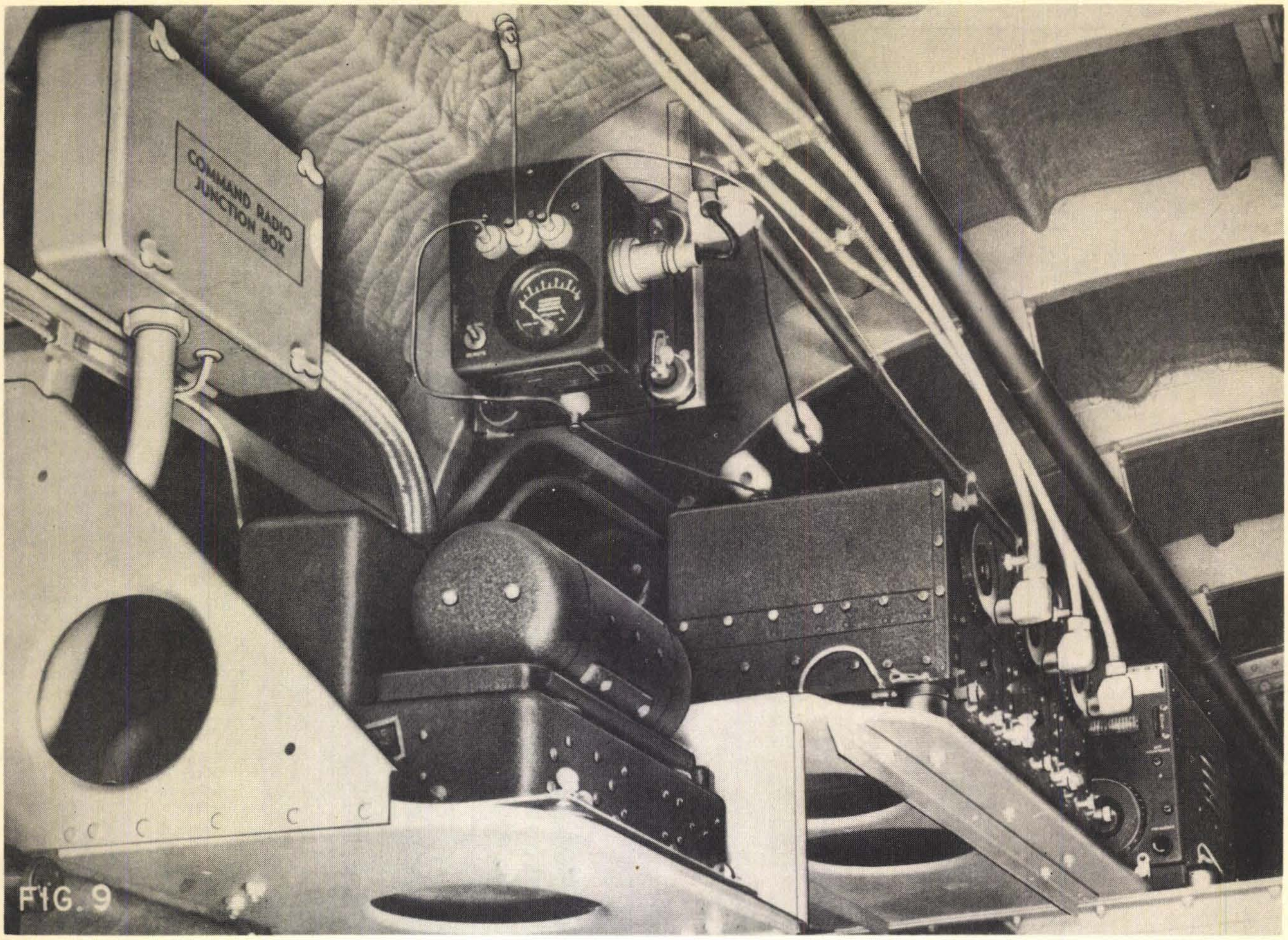


FIG. 9

For interconnection of the transmitter remote control unit with the modulator unit and interconnection of transmitter side tone and receiver output with the interphone system, a junction box has been provided and located overhead in the navigator's compartment immediately above the command modulator unit. This junction box contains terminals only and no other equipment such as relays, resistors, capacitors, etc.

With control of the command set being vested in the pilot and co-pilot only, the mechanical and electrical command set controls, Fig. 10, have been installed on the side of the pilot's cockpit adjacent to the co-pilot's seat. The BC-451-A transmitter control box with its FT-228-A mounting is located immediately aft of the BC-450-A receiver control box with its FT-222-A mounting.

Reception of a signal of a specific frequency is accomplished by the use of the section of the receiver control box which controls the particular receiver involved. In other words the receiver control box is divided into three identical sections each of which controls the particular receiver to which it is electrically and mechanically connected. The desired receiver is turned on and off by a switch located in the upper right-hand corner of the control box section used. This switch in addition to having an "off" position has two selective positions marked CW and MCW each of which is an

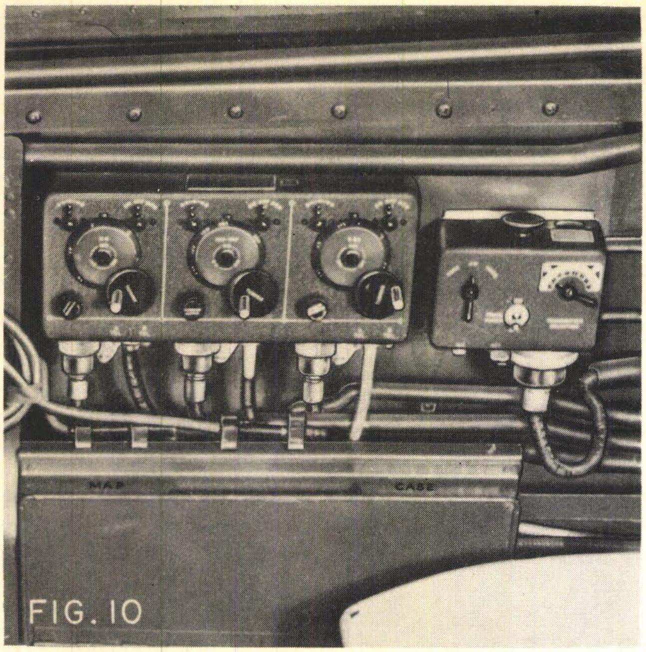


FIG. 10

"ON" position and indicates the type of signal which is to be received.

On the under side of the Receiver control box are located two phone jacks marked "A-Tel" and "B-Tel" through which receiver signal and transmitter sidetone signal may be heard in the headset from the Command Set only. These are not normally used due to the fact that the Command Set is connected into the interphone system, and transmission or reception may be accomplished from any of the eight interphone stations located throughout the ship.

Three controls are located on the face of each section of the transmitter control box and are marked thus: TRANS.POWER, TRANS. SELECTOR, and TONE-CW-VOICE all of which clearly indicate their particular function. On the Switch marked TRANS. SELECTOR will be found four divisions;two of which are used on B-25C airplanes,the other two being reserved for the possible addition of other transmitters. Unlike the command set used on earlier B-25 models, the command receivers and transmitters of SCR-274N set are independently controlled.

Markings on the switch -- "VOICE", "CW" and "TONE" -- clearly indicate the type of signal being transmitted. With the switch turned to the "VOICE" position,the microphone from the jack box switched to the command position will be operative and voice will be transmitted when the push-to-talk button is pressed,while with the switch turned to the "CW" position a "continuous wave", or unmodulated signal will be transmitted, and with the switch turned to the "TONE" position a signal is transmitted which is practically 100 percent modulated at 1000 cycles. For long range communication through interference "CW" is most effective, "TONE" next, and "VOICE" least effective.

On both the CW and TONE positions, the microphone is inoperative on voice, and signalling by code is accomplished by a key which is located on the top of the transmitter control box. If so desired an external or separate key may be used by plugging same into the jack located on the under side of the box and marked "KEY". Adjacent to this jack, marked "KEY",another jack will be found which is marked "MIC" into which a microphone may be plugged by the operator who wishes to transmit voice over the Command Set only, rather than through the interphone system. If the operator so desired, the push-to-talk button on the microphone may be used as a key for transmitting code when the control box switch is turned to the "CW" or "TONE" position.

Operation of this command set is not complicated, however, a thorough and complete study of the pertinent instruction book should be made before operation or servicing is attempted.

LIAISON SET GENERAL

We will now discuss the liaison set which is identified as SCR-287-A and primarily consists of a transmitter with eight interchangeable tuning units, a receiver, telegraph key, dynamotor, frequency meter, antenna tuning unit, and the terminal or junction box, all of which are located in the radio operator's compartment and controlled by the radio operator only. A schematic diagram of the liaison radio system appears in Fig. 11.

The function of the liaison set is for communication over comparatively long distances from ship to base, or ship to ground station, and it is used primarily for reporting ship position or flight progress.

The transmitter identified as BC-375-D and the receiver identified as BC-348-C, Fig. 12, are located on the left-hand side of the radio operator's compartment, immediately forward of the lower turret where by slightly shifting his position the radio operator may control the lower turret guns.

The transmitter covers a frequency range of 260 to 650 KC and 1500 to 12,500 KC by the use of insert tuning units which are listed as follows:

TU-2B covering a frequency range of 260 to 400 KC.
TU-5B covering a frequency range of 1500 to 3000 KC.
TU-7B covering a frequency range of 4500 to 6200 KC.
TU-8B covering a frequency range of 6200 to 7700 KC.
TU-9B covering a frequency range of 7700 to 10000 KC.
TU-10B covering a frequency range of 10000 to 12500 KC.
TU-22B covering a frequency range of 350 to 650 KC.

Tuning unit TU-6B, covering a frequency range of 3000 to 4500 KC., is inserted in the transmitter by the contractor when the ship is delivered. Seven cases, Type CS-48, have been provided for stowage of the spare tuning units and are located; five in the left-hand side of the radio operator's compartment and two in the passageway over the bomb bay.

On the face of each tuning unit is a chart which indicates the approximate dial settings for a desired frequency.

The output from the transmitter is carried through a bare copper wire connected to the transmitter antenna post at one end and to terminal posts of the BC-306-A antenna tuning unit at the other end. From the antenna tuning unit the output is taken to the antenna transfer switch where it is fed to either the fixed or trailing antenna.

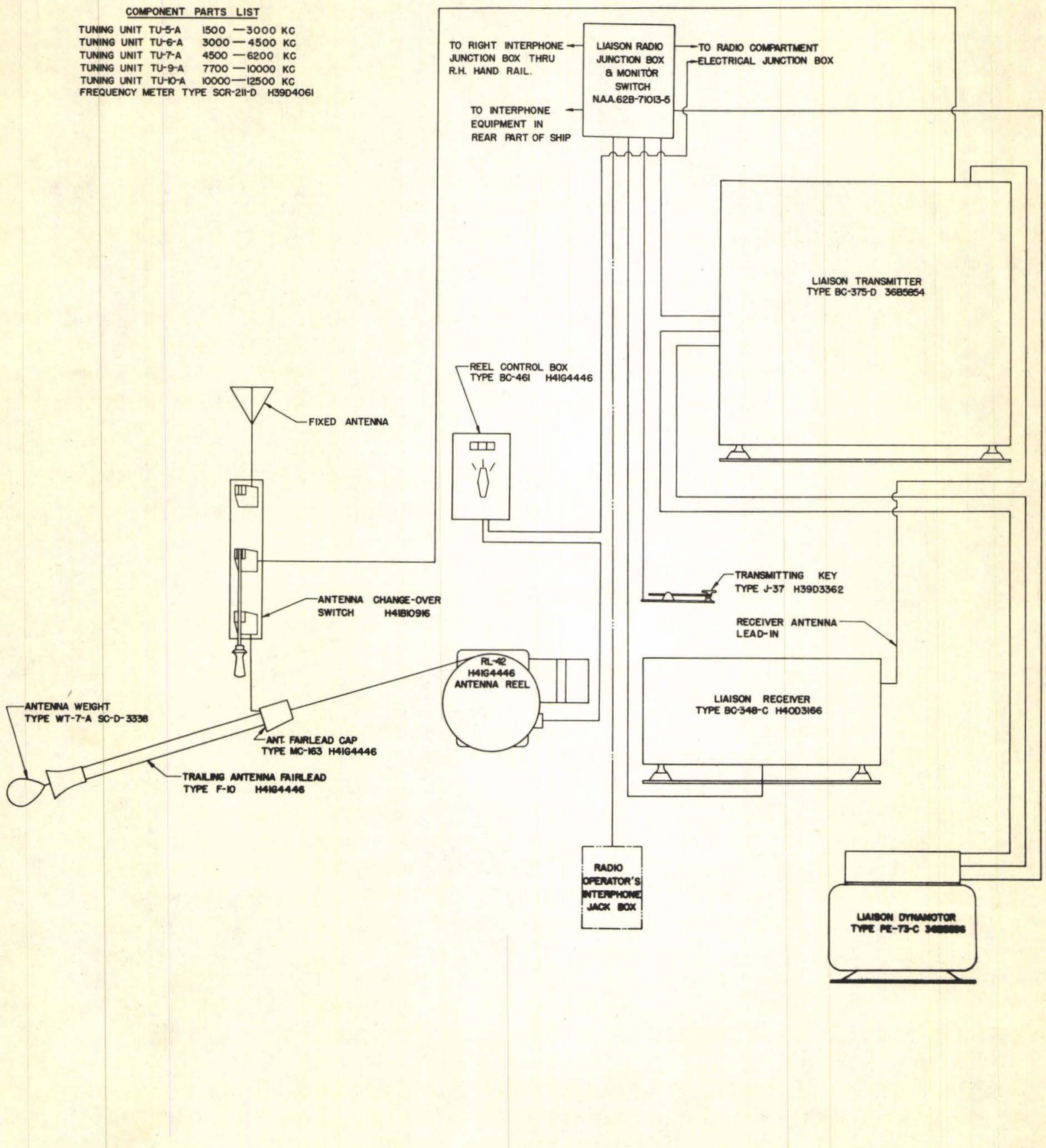


FIG. 11 SCHEMATIC DIAGRAM OF LIAISON SYSTEM (B-25C)

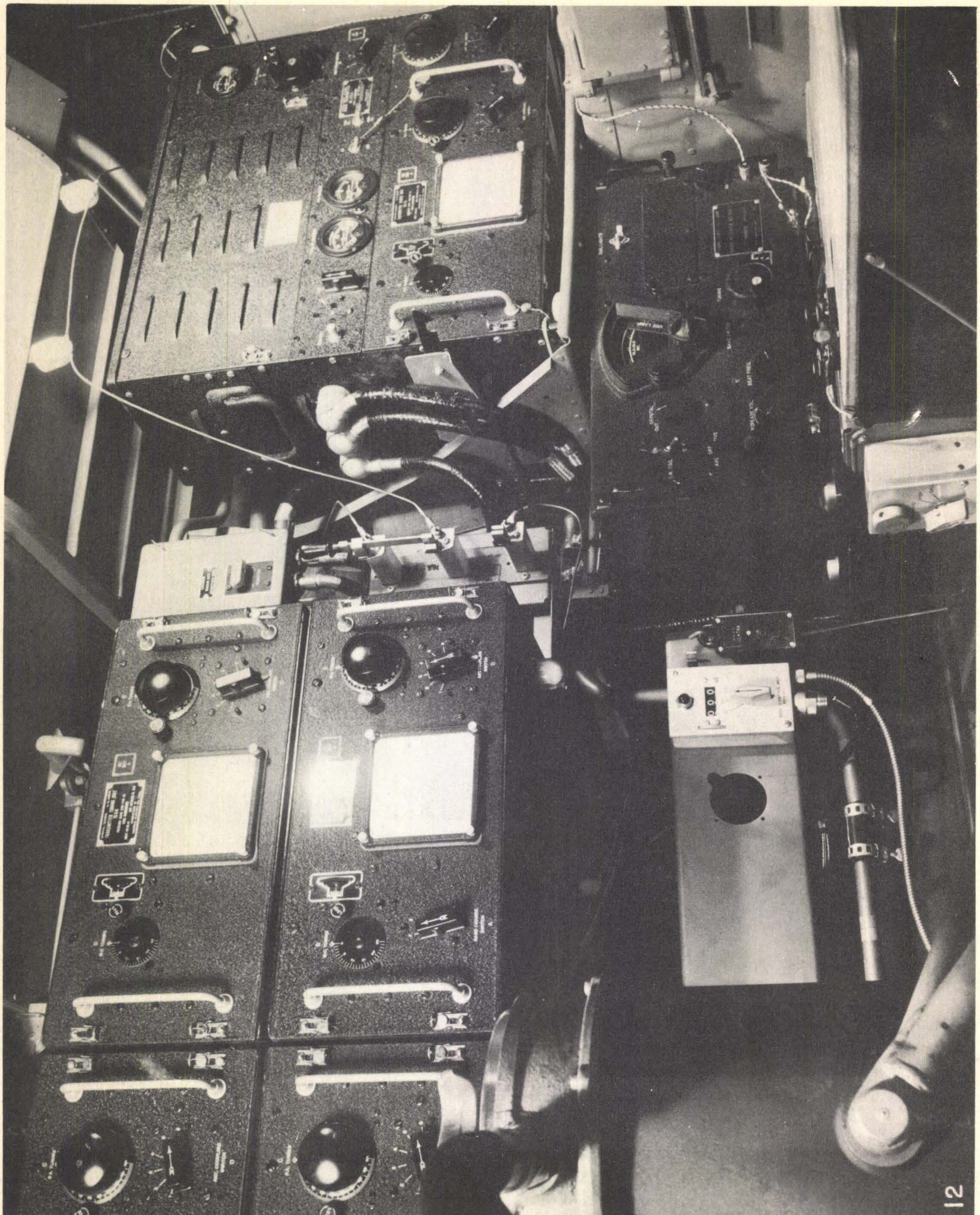


FIG. 12

The antenna transfer switch, X41-B10A16, the purpose of which is to provide a means of switching the liaison equipment from the trailing antenna to the fixed antenna, is located on the left-hand side of the airplane in such a position that it may be conveniently reached by the operator.

The BC-348-C receiver is located on the left-hand side of the ship at the radio operator's writing desk, with the type J-37 transmitting key being located on the folding portion of the desk. This receiver contains a highly selective super-heterodyne circuit capable of voice, tone, or CW reception with manual or automatic volume control and has a frequency range coverage of from 1500 KC to 18,000 KC.

For interconnection of the liaison set components a terminal or junction box has been provided and is located on the left-hand side of the radio operator's compartment immediately under the life-raft compartment, and contains the MONITOR switch and junction terminals only.

The monitor switch consists of two AN3015 switches the operating handles of which are connected together by a bar in order that they must be operated simultaneously. These switches are assembled on the box cover so that when the bar-connected operating handles are thrown from one position to the other, one switch is on and one is off in either position. The switch name-plate carries the marking NORMAL for one position and MONITOR for the other position.

For the purpose of adjusting the frequency indication or radio equipment to within very close limits, a type SCR-211 Frequency Meter has been provided and is located on a shelf on the right-hand side of the radio operator's compartment at the rear entrance of the passageway.

The liaison transmitter dynamotor with its necessary fuses and operating relay is located on the floor under the liaison receiver.

LIAISON SET OPERATION

The transmitter is turned on and off by a switch thus marked, located on the face of the transmitter case. With the transmitter turned on it is IMPORTANT that the filament voltage, as indicated on the meter marked FIL. VOLTAGE, be within close limits of the line on the face of the meter at 10 volts. The C.W. and modulator filament voltages are checked individually by a switch adjacent to the off-on switch.

Each tuning unit contains the necessary tuned circuits to permit a variable frequency transmitter output within the limits specified on the tuning unit in use. As stated before, located on the face of each tuning unit is a chart which indicates the approximate dial switch settings for a desired frequency. The calibration of these settings is quite close, but with the MONITOR SWITCH instal-

lation on these airplanes it is possible to tune the transmitter output frequency to exactly match the frequency of any station coming in over the receiver. With the monitor switch thrown to the MONITOR position, the sidetone of the transmitter is automatically cut-off, and the receiver may be turned on with the CW switch on and adjusted to a desired frequency as indicated on the dial, or to an incoming signal of a station which the operator desires to contact. The transmitter key is then pressed and the transmitter oscillator frequency dial adjusted until the transmitter frequency is heard in the receiver. Trim the transmitter adjustments for maximum output and recheck on the receiver. The transmitter will now be adjusted, and standing by ready for break-in on the station to which it has been adjusted.

With the monitor switch in the position marked NORMAL the receiver will be inoperative while the transmitter is operating, due to the transmit-receive relay cutting off screen grid voltage supply from the receiver tubes. The transmit-receive relay is located within the transmitter.

Microphone or voice input is delivered to the transmitter through only three interphone stations; pilot's, co-pilot's and radio operator's -- the other interphone stations not being connected to provide modulation of the transmitter. Receiver output, however, is delivered to any of the eight jack boxes which may be switched to the liaison or No. 2 position.

Do not attempt to make any internal adjustments, connect or disconnect any wires or bus bars, remove or replace any tubes or change any internal switches or fuses while the transmitter dynamotor is running.

The liaison receiver is turned on and off by a switch located on the front of the case, which in addition to having a position marked off has two other positions, marked MVC and AVC which mean manual volume control and automatic volume control, respectively. Tuning or searching should be done with the switch turned to the MVC position and, after the desired signal has been tuned in, changed to the AVC position if the operator so desires.

Band-switching or selection is accomplished by a knob thus marked and located on the face of the receiver case under the dial window. The band selected is indicated through the dial mask.

The receiver dynamotor is built into the receiver case with its output connections being made entirely within the unit.

Inasmuch as the liaison receiver will not receive signals lower than 1500 KC and the tactical mission of the airplane may require radio reception lower than 1500 KC an auxiliary receiver Fig. 13, has been installed. This "Bendix" receiver identified as RA-10DA is located on the left-hand side of the passageway over the bomb bay. The MR-9C control box is located on a bracket attached to

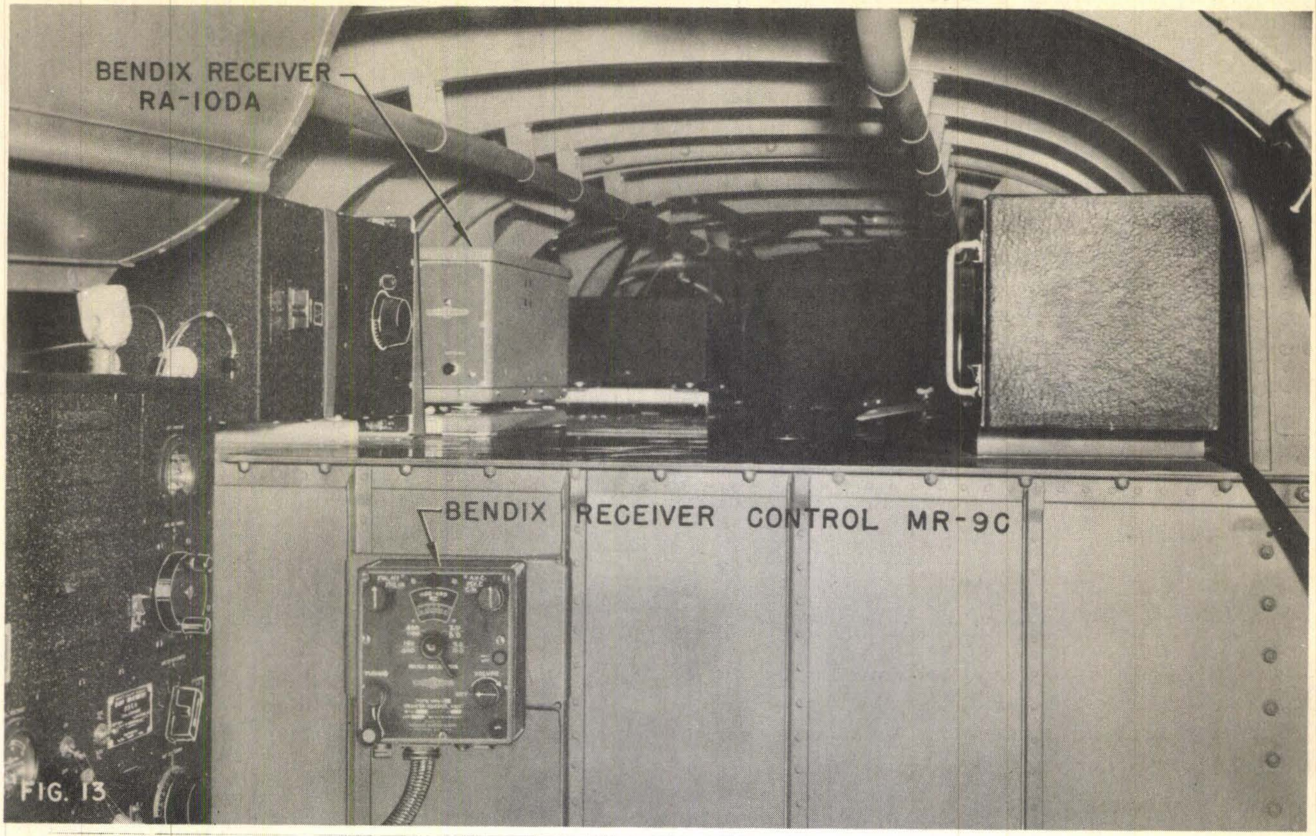


FIG. 13

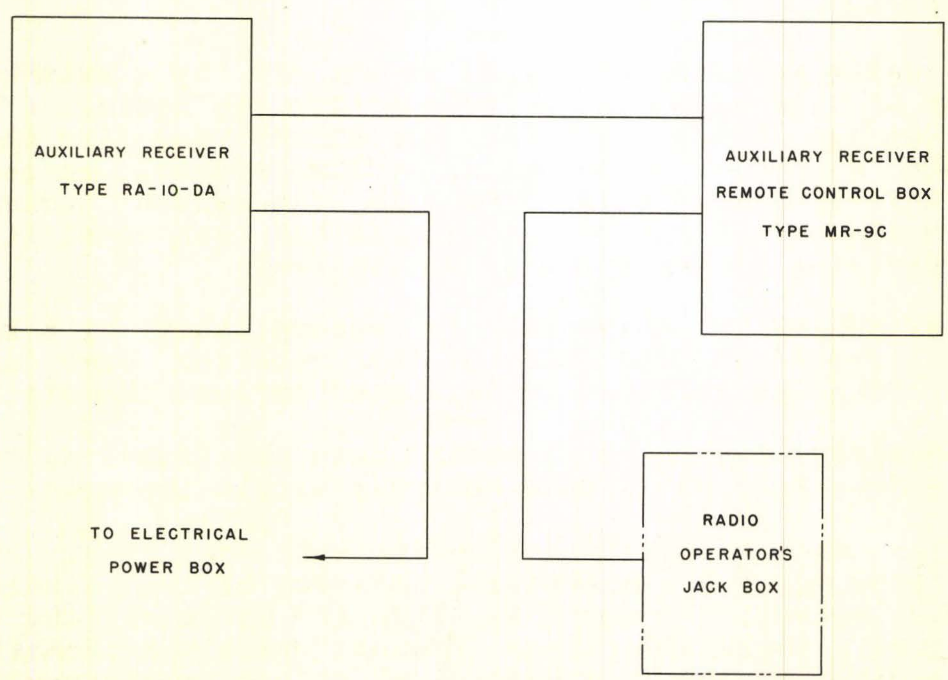
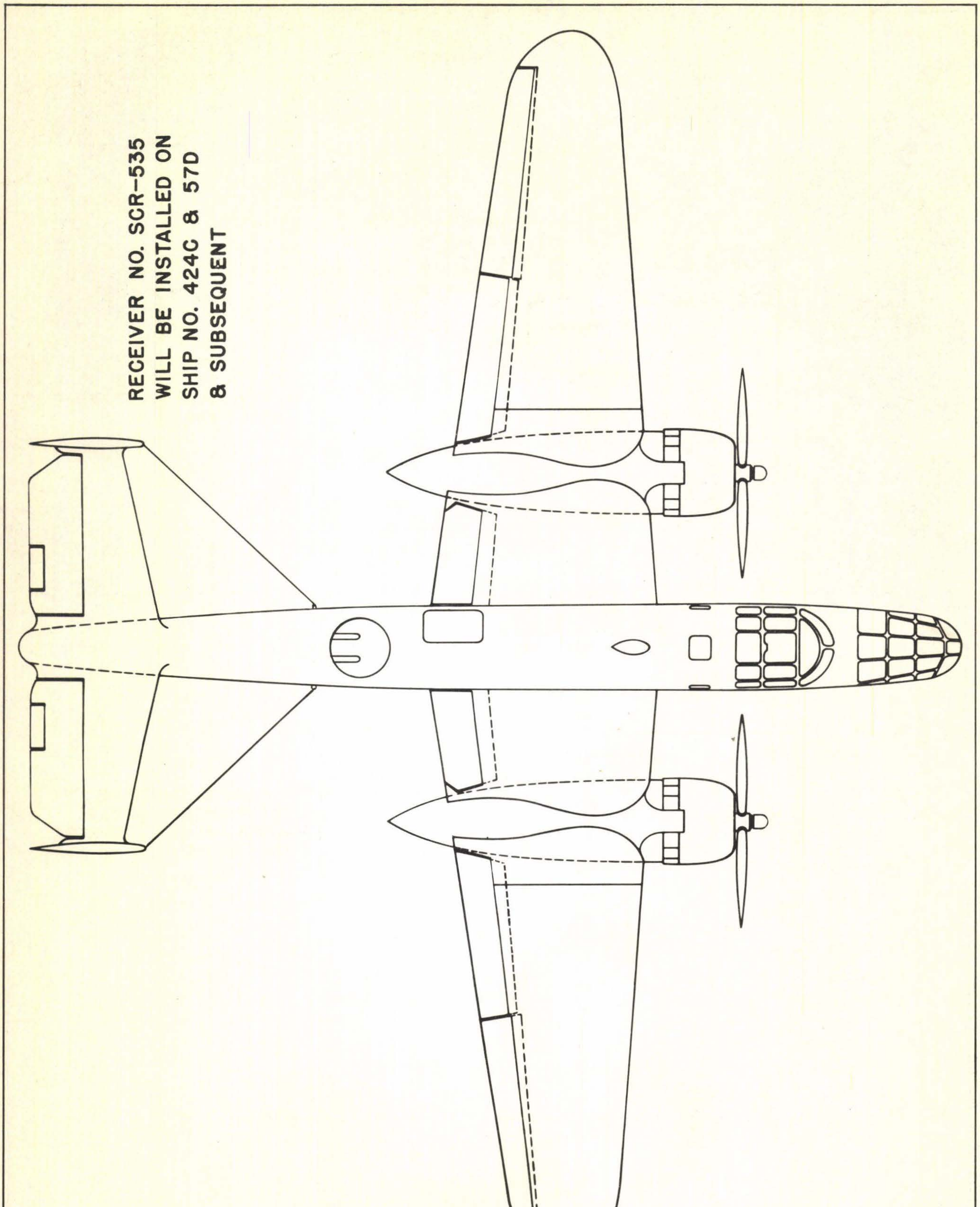
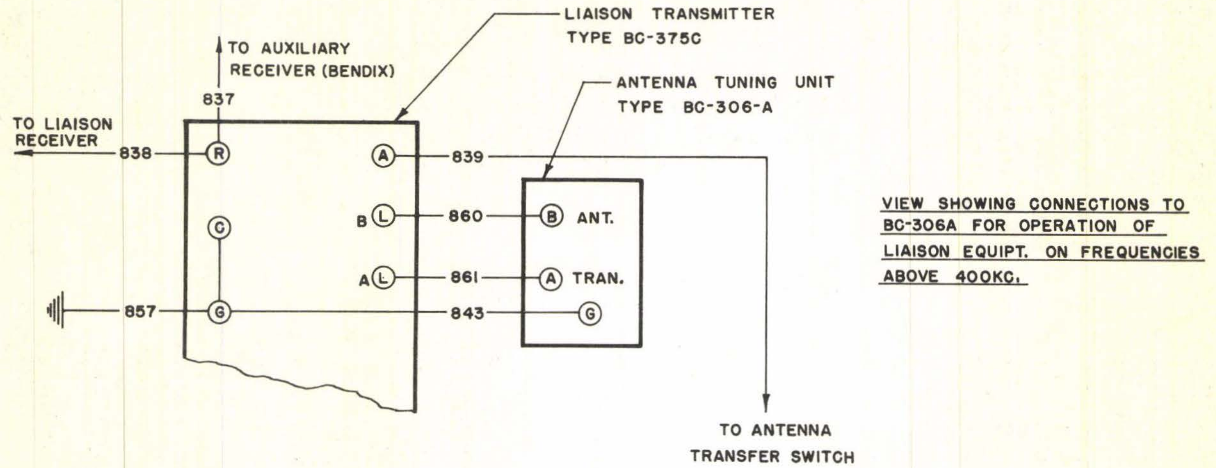


FIG. 14 SCHEMATIC DIAGRAM OF RADIO AUXILIARY RECEIVER (B-25C)


RECEIVER NO. SCR-535
WILL BE INSTALLED ON
SHIP NO. 424C & 57D
& SUBSEQUENT



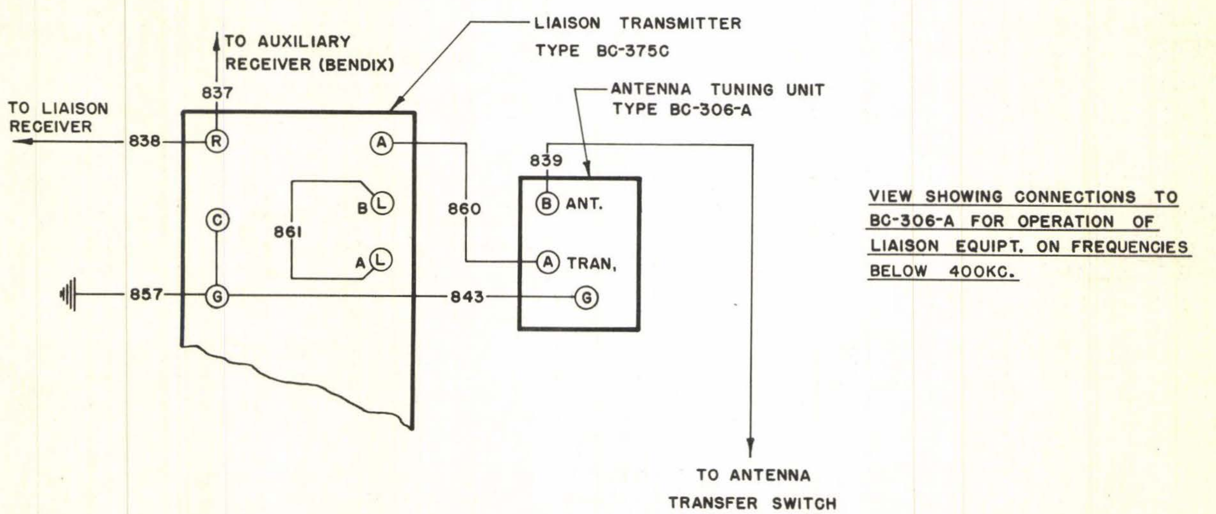


FIG. 15 SCHEMATIC DIAGRAM OF RADIO ALTERNATE ANTENNA TUNING UNIT CONNECTIONS (B-25C)

the bomb bay bulkhead in the radio operator's compartment. A schematic diagram of the auxiliary receiver appears in Fig. 14.

Since the auxiliary receiver is remotely controlled,it is connected to the control box by a flexible shaft Bendix No. A15410, eighty-five (85) inches in length.

In order to tune the antennae for transmission on the lower frequencies, a BC-306-A antenna tuning unit has been provided and installed in the passageway with its antenna connections adjacent to those of the liaison transmitter. Since different interconnections of the high frequency leads from the transmitter to the antenna tuning unit are required for frequencies above 400 KC than those below, a chart, Fig. 15, has been prepared which shows the alternate hook-up of these two units.

RADIO COMPASS GENERAL

The radio compass, identified as SCR-269-A, generally speaking consists of a receiver, two remote control boxes, a right-left indicator, a rotatable loop, a loop direction indicator, a relay for shifting control, the necessary control shafting, and a terminal or junction box. A schematic diagram of the radio compass appears in Fig. 16.

The radio compass receiver unit, identified as BC-433-A, is a 15-tube super-heterodyne receiver having a frequency reception range of from 200 KC to 1750 KC. Considering the compass and liaison receivers it will be noted that this airplane has a continuous frequency reception coverage of from 150 KC to 18,000 KC.

Two types of current are necessary for operation of the radio compass: Four hundred cycle, one hundred ten volt A. C., which is furnished by an inverter, for operation of the radio circuits and twenty-eight volt D. C. supplied by the ship's battery for operation of the radio compass relays.

The radio compass receiver, Fig. 17, is located on the left-hand side of the forward entrance to the passageway over the bomb bay.

The two control boxes identified as BC-434-A, are located on the left-hand side of the ship;the pilot's control box being installed adjacent to the pilot's aileron control wheel, and the navigator's control box being installed forward of and below the navigator's window. The controls are mechanically connected by MC-124 shafts to an MC-203 tee coupling which in turn is mechanically connected by an MC-124 shaft to the compass receiver.

The loop antenna, identified as LP-21-A, is located outside and on top of the ship immediately over the navigator's compartment and is enclosed in a streamlined housing. The loop is automatically electrically operated and indication of setting is read directly

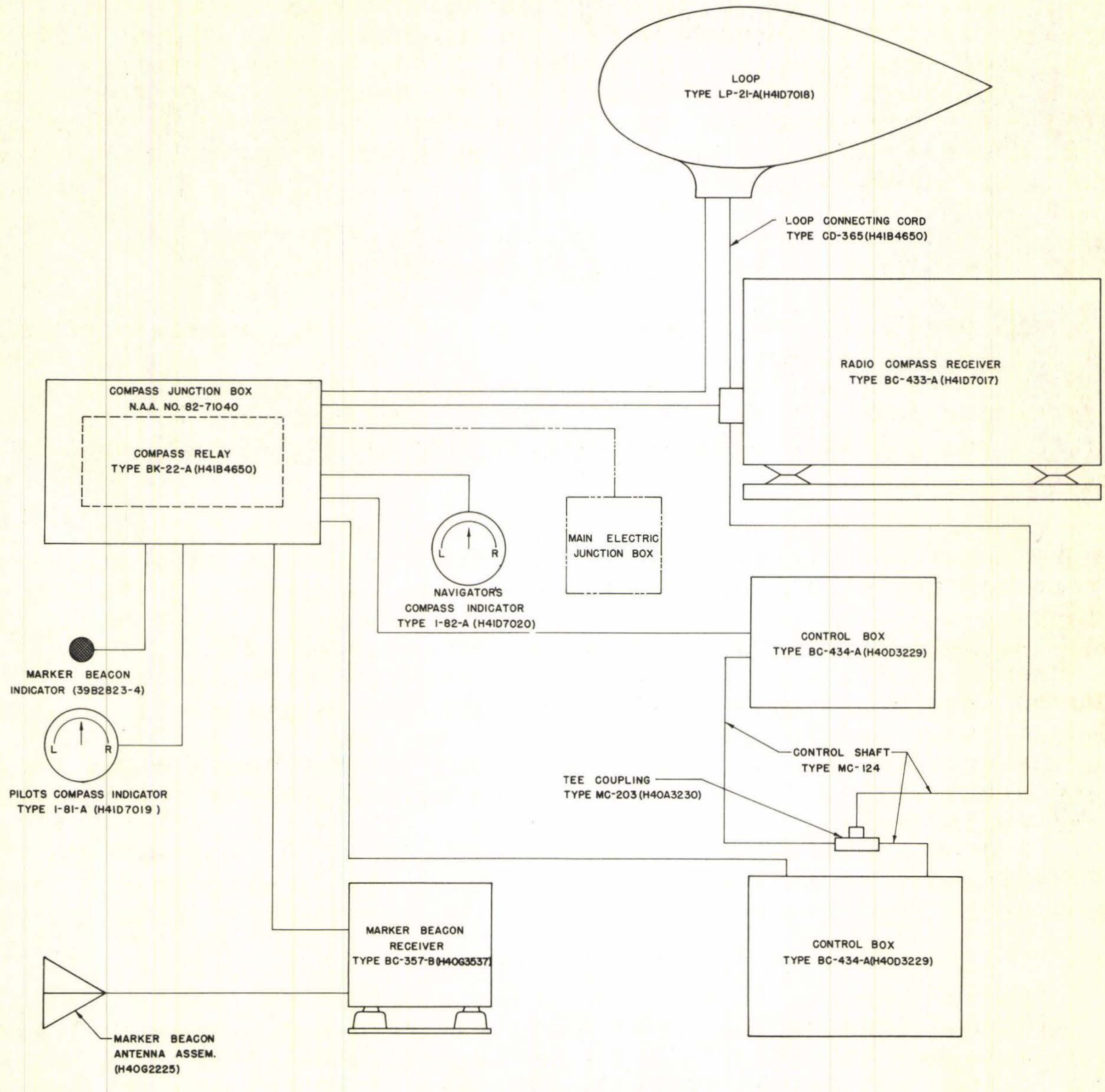


FIG. 16 SCHEMATIC DIAGRAM OF RADIO COMPASS SYSTEM (B-25C)

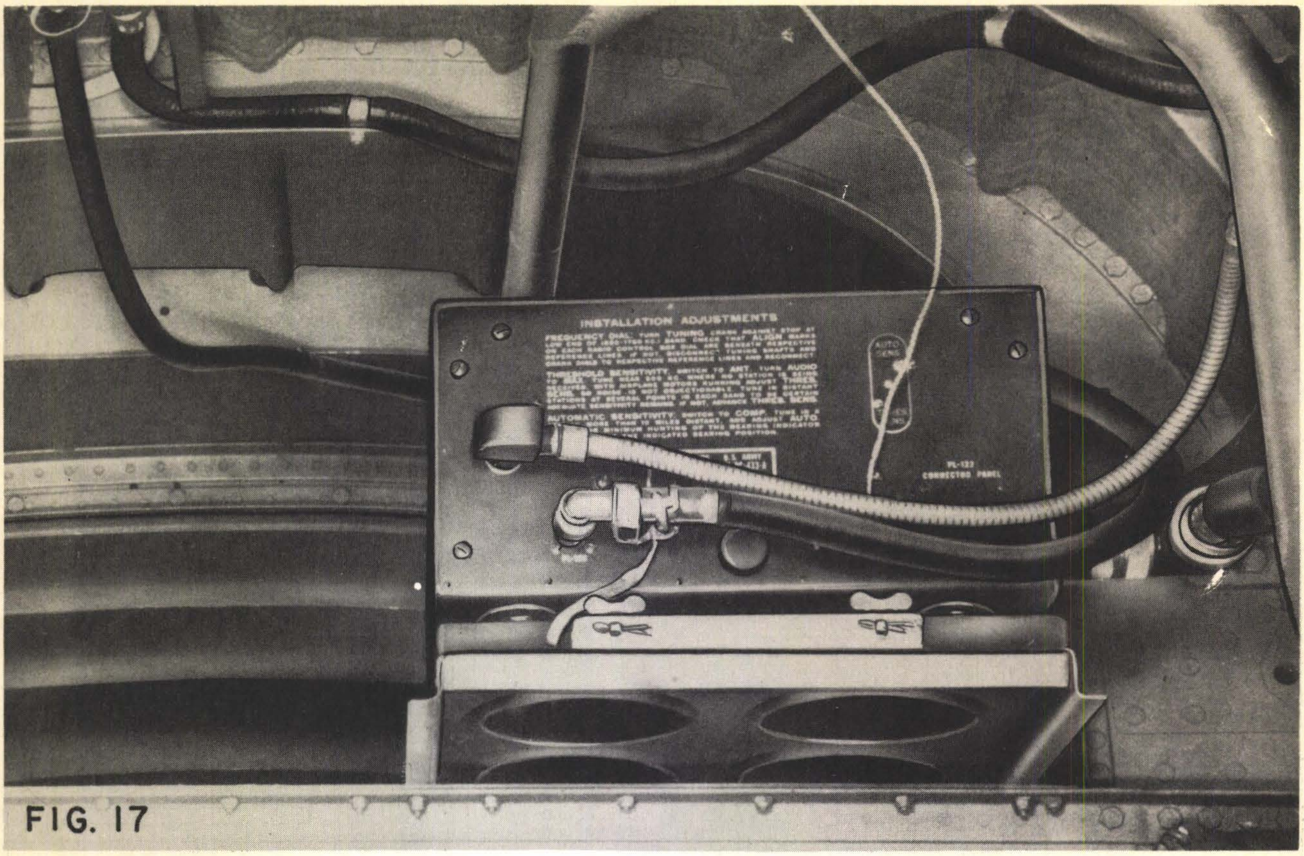


FIG. 17

from the indicators. Electrical connection from the receiver to the loop is accomplished by a type CD-365 cord.

The type I-81-A pilot's indicator is located on the pilot's instrument panel, and the type I-82-A navigator's indicator is located on the navigator's chart table.

Interconnection of the various units is accomplished by use of the terminal posts provided on the face of the type BK-22-A relay, for which a housing or junction box has been provided and located on the left-hand side of the ship immediately aft of the navigator's window.

RADIO COMPASS OPERATION

The radio compass is operable from either of the two control boxes, but not both at the same time. The equipment is manually tuned from either remote control box and electrical control is established at the desired control box by depressing the button in the lower right-hand corner of the control box marked "CONTROL". When control is established at the desired remote control unit, a green indicating light will appear on the face of the control unit.

The radio compass equipment is designed to perform the following functions: (a) Give aural reception from the fixed antenna or from the rotatable loop. For signal reception during interference

caused by precipitation static or proximity of signals, the loop will prove superior. (b) Aural-null directional indication of an incoming signal with the loop only in use. (c) Visual unidirectional left-right indication of an incoming signal.

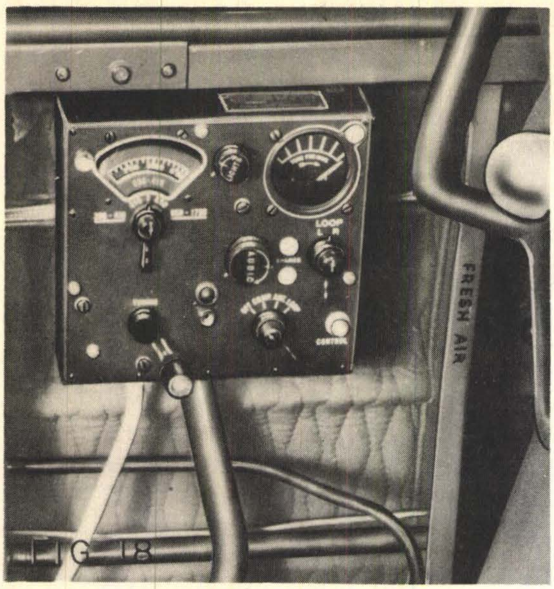


FIG 18

The receiving unit is turned on or off by a switch on the face of the remote control box, Fig. 18, which in addition to having an OFF position marked thereon has three other positions marked thus: COMP. ANT. and LOOP. With the switch turned to the position marked "COMP"., both the rotatable loop and the fixed antenna are in use while with the switch turned to the position marked "ANT"., only the fixed antenna is in use and with the switch turned to the position marked "LOOP", only the rotatable loop is in use. Band selection is accomplished by rotating the band switch to the frequency band in which operation is desired.

MARKER BEACON GENERAL

The marker beacon receiving equipment, identified as RC-39, Fig. 19, consists of a receiver, antenna, and an indicating or signal light.

The marker beacon equipment is designed to operate on 75 MC (ultra-high frequency) signals. Its purpose is to receive signals transmitted from instrument landing systems, fan stations, cone of silence stations, and other facilities employing 75 MC horizontally polarized transmission patterns.

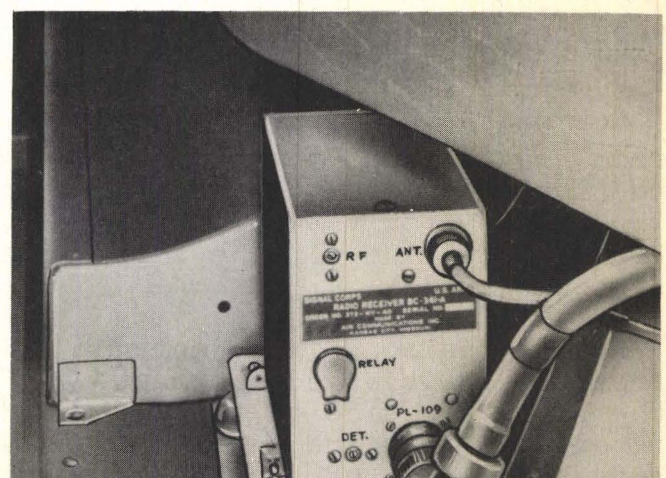


FIG. 19

The marker beacon equipment relies entirely on the compass equipment for its power supply, and is therefore interconnected to the compass equipment through a conduit extending from the marker beacon receiver to the compass junction box.

The marker beacon receiver identified as type BC-375-B is located on the left-hand side of the navigator's compartment

floor immediately forward of the map case where it may be easily reached for adjustment or maintenance.

The marker beacon indicator, identified as 39B2823-4 and located on the pilot's instrument panel, is a signal lamp having an amber jewel cover and equipped with a 14 volt .15 amp. bayonet base type T-3 1/4 lamp.

The marker beacon antenna transmission line WC-358 is routed from the receiver forward under the floor to a fitting provided in the under side of the ship.

MARKER BEACON OPERATION

Since the operation of the marker beacon equipment is fully automatic there is no manual operation required.

As the ship passes over a fixed point from which a marker signal is being transmitted, the signal is picked up by the receiver, the output of which actuates a built-in relay. This relay in turn causes the indicator to flash on, thus indicating to the pilot that he has passed over a marker beacon.

ANTENNA SYSTEM

The antenna system, Fig. 20, consists of five separate antennae made from type W-106-A wire. Each antenna has a separate and distinct function with relation to the equipment installed in the airplane.

Three of these fixed antennae use a common mast at their forward point of attachment, the mast being located on the top of the ship immediately aft of the pilot's compartment.

The command set antenna is a TEE type antenna which extends from the forward common mast, aft to an attaching clip located on the inner top side of the right-hand vertical stabilizer. The lead-in extends from the antenna to a type IN-79 insulator located in the right-hand side of the ship adjacent to the command set antenna switching relay.

The liaison fixed antenna is a TEE type antenna which extends from the forward common mast, aft to an attaching clip located on the inner top side of the left-hand vertical stabilizer. The lead-in extends from the antenna to a type IN-84 insulator located in the left-hand side of the ship, adjacent to the liaison change-over switch (Reference Technical Order 08-5-2A).

In order that the fixed antennae may be invulnerable during gunnery practice two identical antenna attaching clips have been installed on the lower inner side of the vertical stabilizers. During gunnery practice the antennae may be removed from their normal

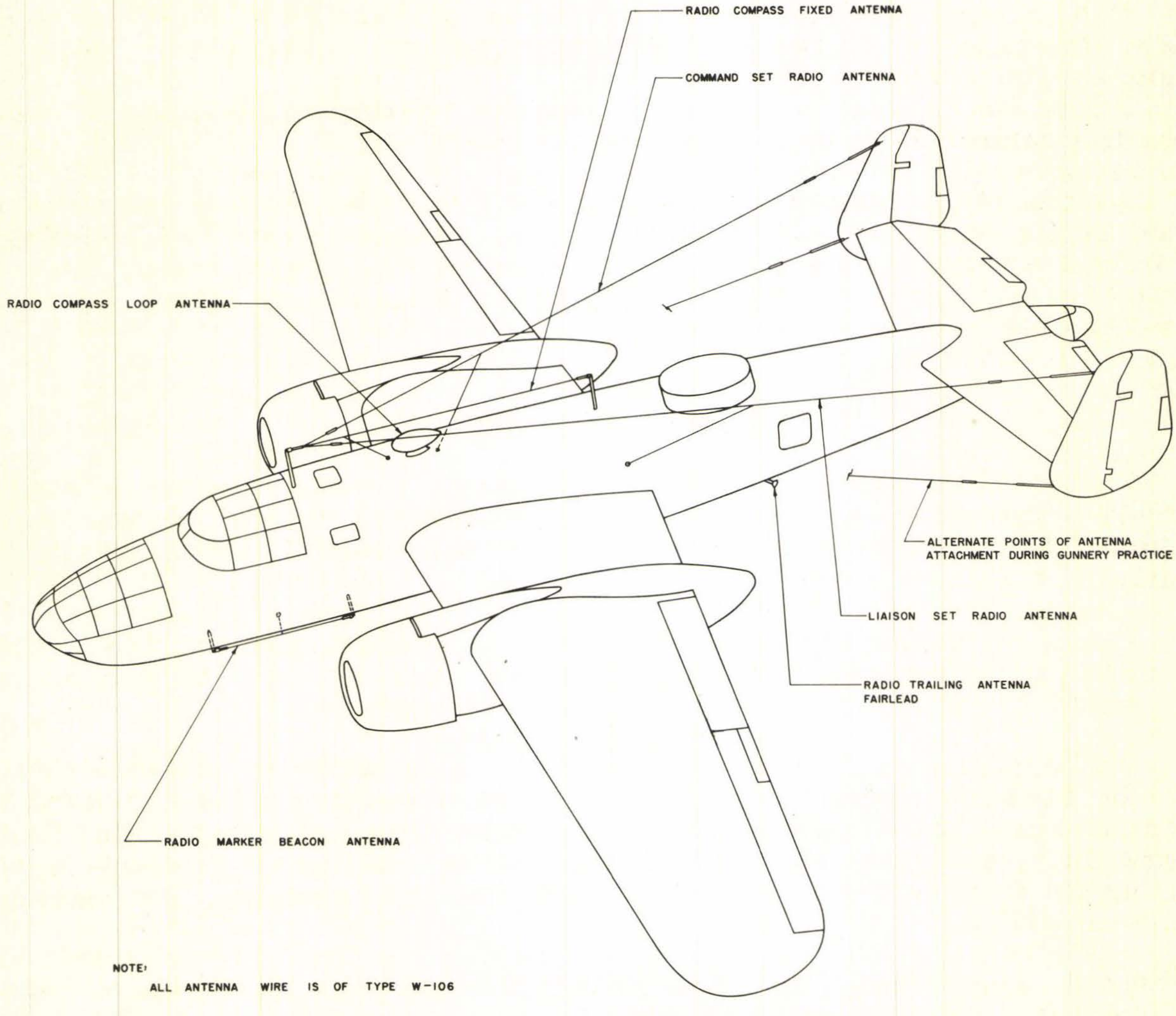


FIG. 20 RADIO ANTENNA INSTALLATION

points of attachment and be attached to the lower clips without any alteration in their length.

The radio compass fixed antenna is of an inverted L type which extends from the forward common mast to a mast located on top of the ship at the rear of the bomb bay. The lead-in extends from the antenna to a type IN-79 insulator located on the ship immediately forward of the loop. A shock link has been installed near the rear point of attachment in the liaison set and command set antennae. Insulation has been accomplished by the use of type IN-88 strain insulators at each point of attachment.

The contractor has established an initial tension of 15 lbs. in the command and liaison antennae and an initial tension of 10 pounds in the compass fixed antenna.

The marker beacon antenna is located on the under side of the ship adjacent to the nose wheel landing gear, and has been designed and installed in accordance with Air Corps Drawing No. H40G2225. There being no shock link used in the marker beacon antenna, an initial tension of 3 to 5 pounds is sufficient.

The liaison trailing antenna is wound on a type RL-42 reel which is located on the lower left-hand side of the upper turret compartment. The W-106-A wire is fed from the reel through a phenol fibre tube fairlead to the type F-10 fairlead where a type WT-7-A antenna weight is attached.

The BC-461 Reel Control Box is located on a bracket on the left-hand side of the radio operator's compartment immediately aft of the liaison receiver where it may be conveniently reached for operation by the radio operator.

GENERAL RADIO OPERATION

Radio operation, being of highly specialized nature, especially the radio compass equipment in its relationship to navigation, no attempt has been made in this discussion to give detailed instruction on this subject.

Persons unfamiliar with the radio equipment should not make an attempt to operate any of the equipment until a thorough study of the Books of Instructions has been made. The Books of Instructions are stowed in the data case in the radio operator's compartment. (Reference, T. O. 08-5-2.)

TROUBLE SHOOTING

Failure of the radio equipment to function when turned on should be checked first at the source of current supply to the particular unit involved.

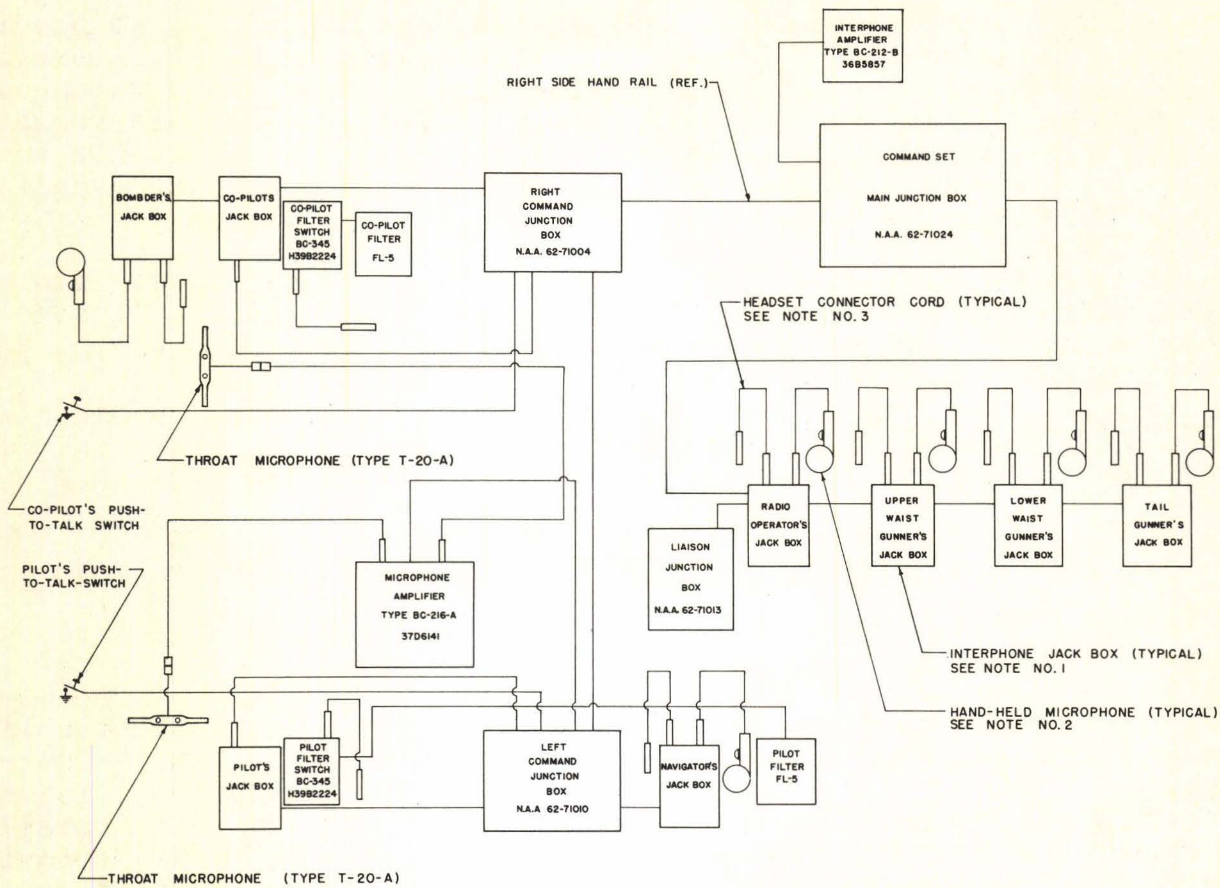
Current supply proving active at the initial source but inactive at its entrance to the unit involved, indicates that a continuity check of the wiring should be made. Defective wires, if any, should be replaced in their entirety with wires of the same gauge as those which they replace. For the convenience of the personnel making such continuity checks, a chart has been installed in the junction box covers showing the terminal connections of wires within the box.

Inoperative government furnished equipment should be checked in accordance with the instructions given in the Book of Instructions applicable to the unit involved. Inoperative units which cannot be made operative by tube replacement or internal fuse replacement, or by very minor repairs, should be replaced with units known to be operative and the defective unit routed through the usual Air Corps channels for repair.

For fuse capacities and locations of fuses built into the government furnished equipment, the instruction book applicable to the unit in question should be consulted.

NOTE

The radio equipment listed in this lecture is for instruction purposes only. Instructions on some of the equipment that is installed on the present airplanes, due to vast changes required, is not included in this lecture. Certain new pieces of equipment installed is considered confidential and instruction on this equipment will be given to properly qualified personnel by Air Corp Authorities.



NOTE:—

1. ALL INTERPHONE JACK BOXES ARE TYPE BC-366 (H40D2226)
2. ALL HAND-HELD MICROPHONES ARE TYPE T-17 (35D3887)
3. ALL HEADSET CONNECTOR CORDS (36B4044) CONSISTS OF ONE JACK (TYPE JK-26) AND ONE PLUG (TYPE PL-55) EACH, PLUS THE REQUIRED LENGTH OF CORDAGE (TYPE CO-119)

FIG. 21 SCHEMATIC DIAGRAM OF INTERPHONE EQUIPMENT (B-25 AND B-25A)

ADDENDUM I

Items peculiar to B-25, B-25A and B-25B Airplanes only.

1. GENERAL

This lecture deals with the radio installation in Model B-25 type airplanes of which there are three type designations; namely, B-25, B-25A and B-25B, all having 12-volt D. C. current supply. Primarily these installations consist of radio equipment for bombardment airplanes as outlined in the Handbook of Instructions for Airplane Designers, Vol. II, 8th Ed. 2nd Revision. Generally speaking the radio system consists of the following:

Command Set, which is normally used for ship to ship communication.
Medium Range Liaison Set, which is used for ship to base, or ship to ground communication.
A Radio Compass Receiver, which is used for direction finding in cross-country air navigation.
Marker Beacon Receiving Equipment, which is used in conjunction with the instrument landing system.
Multiplace Interphone System, which provides intercommunication between crew members, and being interconnected with the radio systems, provides for receiving or transmitting from specified crew stations.

2. INTERPHONE SYSTEM GENERAL

First in our description of the radio equipment installation, we shall discuss the interphone system installed in B-25, B-25A and B-25B, which in each of the models is practically identical with the exception of a slight change in location of phone stations, due to a change in armament on model B-25B.

The interphone system, Fig. 21, type RC-45, in these models consists of a type BC-212B Interphone Amplifier, one BC-366 Jack Box for each phone station with the specified microphone -- either T-17 hand-held, type T-20 or T-30 throat microphone, or a combination of each as the case demands.

Each interphone station is provided with a headset connector cord equipped with a PL-55 plug at one end, which plugs into the jack box, and a JK-26 jack into which the user's head set plugs. Stowage clips are provided adjacent to the respective jack boxes for stowing the JK-26 jack of the head set cord, and a stowage clip and hook is provided for stowing the hand-held microphone while not in use.

The pilot and co-pilot are provided with Type T-20 throat microphones which require an amplifier; therefore, a type BC-216-A throat microphone amplifier has been provided and is located on the left-hand side of the airplane immediately aft of the pilot's seat, with plug-in extension cords extending to the pilot's and co-pilot's jack boxes.

In order to talk into the interphone system, the use of a press-to-talk push-button switch is necessary. This switch is built into, and forms a part of, T-17 hand-held microphone; while for throat type microphone operation, the contractor has provided push-button switches located conveniently for operation by the wearer of the throat microphone.

The bombardier's interphone station, consisting of a Jack Box, a T-17 Hand-Held Microphone and headset connector cord, is located on the right-hand side of the bombardier's compartment or nose section of the ship.

The pilot's and co-pilot's interphone stations are located on the left and right-hand sides of the ship, respectively, adjacent to the aileron control wheel and consist of the same equipment with the addition of a type BC-345 switch box and a type FL-5 filter for each station.

The navigator's interphone station, consisting of the same equipment, is located in the navigator's compartment on the left-hand side of the airplane just below the window.

In discussing the interphone system and jack box locations the following applies to models B-25 and B-25A:

The radio and camera operator's interphone station consisting of the same equipment, is located on a supporting member immediately forward of the liaison receiver.

The upper and lower waist gunner's interphone stations consist of the same equipment and are located on the left side of the ship adjacent to their respective gun stations.

The tail observer's interphone station, consisting of the same equipment, is located in the tail section of the airplane.

We will now describe the interphone equipment as installed in Model B-25B, Fig. 22. As stated before, the difference in the radio equipment installation is due to a change in armament; namely, swivel guns have been replaced with turrets. A turret operator having both hands occupied cannot use a hand-held microphone,therefore, T-30 throat microphones have been provided at the upper and lower turrets. Since no amplifier is required for T-30 throat microphones, they are,therefore, connected through push-to-talk switches directly to jack box plugs.

The upper turret gunner's interphone jack box is located on the left-hand side of the airplane, just below the upper longeron in approximately the same position as the top waist gunner's jack box on models B-25 and B-25A. Connected to plugs PL-55 and PL-68 at the jack box is a four-conductor shielded cable which extends downward, terminating in an AN-3106 plug located on the upper turret junction box. The microphone and headset circuits are carried from slip rings in the base of the turret up through the column to a press-to

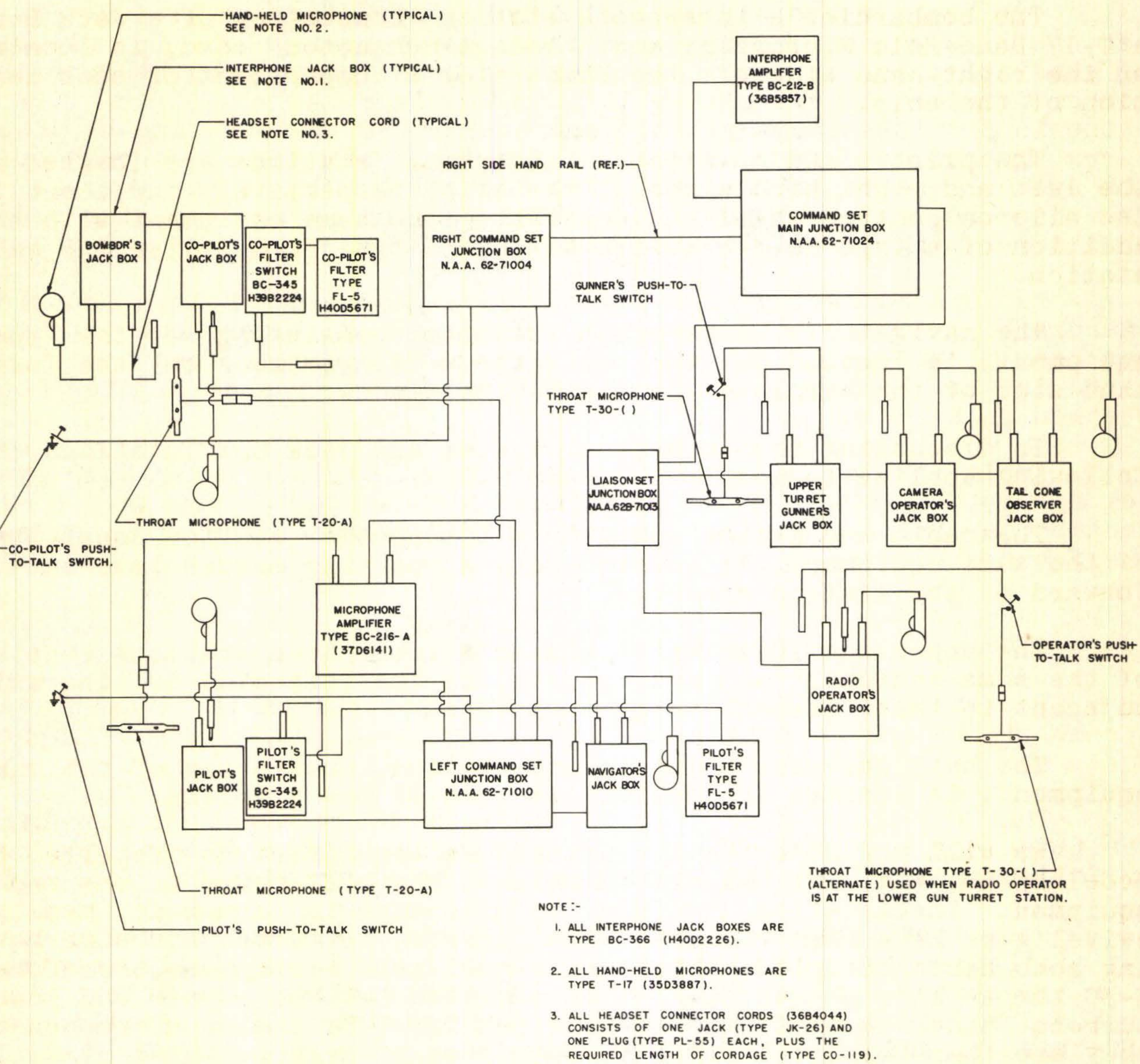


FIG. 22 SCHEMATIC DIAGRAM OF INTERPHONE EQUIPMENT (B-25B)

talk push-button switch which is provided by the turret manufacturer and is located on the left-hand side of the turret. The gunner's throat microphone extension cord and headset extension cord connect his T-30 throat microphone and headset respectively to a four-post terminal block, furnished by the turret manufacturer and located within the turret mechanism housing.

The radio operator, in addition to operating the liaison radio set, acts as gunner and operates the lower turret guns. For his use of the interphone system a jack box has been located on a supporting member immediately aft of the liaison receiver. A T-30 throat microphone is provided for the radio operator's use while acting as lower turret gunner, and is connected to the jack box through a push-button switch located in the left-hand control handle of the turret. A T-17 hand-held microphone is provided for the radio operator's use while operating the liaison equipment.

The camera having been moved aft on Model B-25B to a location immediately aft of the rear entrance hatch, an interphone station has been provided for the use of the camera operator, and it is located in the same position as the lower waist gunner's interphone station on B-25 and B-25A.

Amplification being required for a multiplace interphone system a type BC-212-B interphone amplifier which is common to all models, has been installed immediately forward of the command set shelf and above the upper longeron.

3. INTERPHONE SYSTEM OPERATION

The interphone system deriving its power from the command set dynamotor, is only operative while the command radio set is turned on.

The interphone jack box, of which there are eight in the ship, has five selective positions which are marked on the face of the box as follows and with which it is possible to accomplish the following:

Position 1, marked "COMPASS". In this position the audio output of the compass receiver only will be heard. A limited control over the headset volume can be had by manipulating the volume control. The microphone circuit is inoperative. This position is effective on all interphone stations.

Position 2, marked "LIAISON". In this position the liaison receiver output and the side tone of the liaison transmitter will be heard. A limited control over the headset volume may be had by varying the volume control. The microphone push-to-talk switch operates the transmit-receive relay located within the liaison transmitter. The microphone will modulate the liaison transmitter when the switch is closed, and transmitter is in "voice" position.

This jack box position is effective only on the pilot's, co-

pilot's and radio operator's interphone stations, since it is undesirable to have other crew members modulate or transmit voice over the liaison transmitter.

Position 3, marked "COMMAND". In this position the command receiver output and side tone of the command transmitter will be heard. A limited control over the volume can be had by varying the volume control. The microphone push-to-talk switch operates the command transmit-receive relay which is located in the command radio junction box. The microphone will modulate the command transmitter when the push-to-talk switch is closed and the transmitter is in "voice" position. This position is effective on all interphone stations.

Position 4, marked "INTER". All jack boxes turned to this position provide an intercommunicating system for use between crew members. The microphone connects to the input of the interphone amplifier and the headphones to the output of this amplifier. The volume control is not effective in this position. This position is effective on all interphone stations.

Position 5, marked "CALL". This is an emergency call position in which all of the positions in all boxes are placed in parallel across the putput of the interphone amplifier. In other words, should an emergency arise in which a crew member wishes to call an interphone station which may be in use, he may do so by switching his jack box to this call position. The microphone in this position is connected into the input of the interphone amplifier. This position is effective on all interphone stations.

You are probably all familiar with the simultaneous range setup or the broadcasting of weather reports at periodic intervals on the same frequency as the beacon signal. The FL-5 filter is a device used for separating the voice giving the weather reports, from the beacon signal. The BC-345 switch box is a selector switch used in connection with the filter, and permits the pilot to select a combination of beacon signal only; beacon signal and weather reports or weather reports only. The selection is accomplished by turning the knob on the face of BC-345 switch box to the desired marking: Voice, Range or both. These devices identified as RC-32 filter equipment are provided for the pilot and co-pilot only.

THROAT MICROPHONE. - The BC-216-A throat microphone amplifier is a high gain amplifier in which the voice level of the throat microphone is brought up to the voice level of the regular T-17 microphone. The output of this amplifier is then sent into the interphone system at approximately the same level as that produced by the use of a T-17 microphone. The throat microphone amplifier is common for the throat microphone of both pilot and co-pilot. Like the balance of the interphone equipment it receives its power from the command set dynamotor and is only operative when the command set is turned on. The output of the amplifier is connected to the interphone system through a push-button switch on the pilot's and co-pilot's wheel. These push-button switches are functionally identical to the push-to

talk switch buttons on T-17 hand-held microphones, and when depressed, the output of the amplifier is connected to the interphone system. The gain control on the face of the throat microphone amplifier may be adjusted so the voices of the wearers of the throat microphones may attain an output level comparable to that which should be expected were they using T-17 hand-held microphones.

4. COMMAND SET GENERAL

We will now discuss the command set which is identified as SCR-AL-183 and primarily consists of a transmitter and receiver with a control box for each, a remote tuning unit for tuning the receiver, an antenna switching relay for switching the antenna from the receiver to the transmitter, plus the necessary terminal or junction box.

In making this installation we have grouped the BC-AL-230 transmitter, the BC-AL-229 receiver and the BC-AL-198 antenna switching relay, and installed this group on a shelf in the upper right-hand portion of the radio operator's compartment.

The command set is a short range radio communication system, Fig.23, and as stated before is used primarily for ship to ship communication. The type BC-AL-230 transmitter covers a frequency range of 2500 KC to 7700 KC by the use of insert coils, known as spare coils, which are identified as follows:

C-271 having a frequency range of 2500 to 3200 KC.
C-272 having a frequency range of 3200 to 4000 KC.
C-273 having a frequency range of 4000 to 5000 KC.
C-274 having a frequency range of 5000 to 6210 KC.
C-275 having a frequency range of 6200 to 7700 KC.

For stowage of these spare coils, type CS-47 cases have been provided and installed on the right-hand side of the radio operator's compartment.

In the transmitter will be found a type C-184 crystal-controlled coil, the crystal of which is ground to a frequency of 4495 KC.

The type BC-AL-229 receiver covers three frequency ranges of 201 to 398 KC, 2500 to 4700 KC and 4150 to 7700 KC. This frequency range is accomplished by the use of insert coils, one single coil set identified as type C-171 which covers a frequency range of 2500 to 4700 KC, and a dual coil set identified as C-155-A which covers a frequency range of 4150 to 7700 KC in the high frequency band and a frequency of 201 to 398 KC in the low frequency band. The C-171 single coil set is normally carried in a type CS-44 stowage case, which in the case of models B-25 and B-25A is mounted on the right-hand side of the radio operator's compartment just forward of the window and in the B-25B model, is mounted on the bulkhead forward of the upper turret.

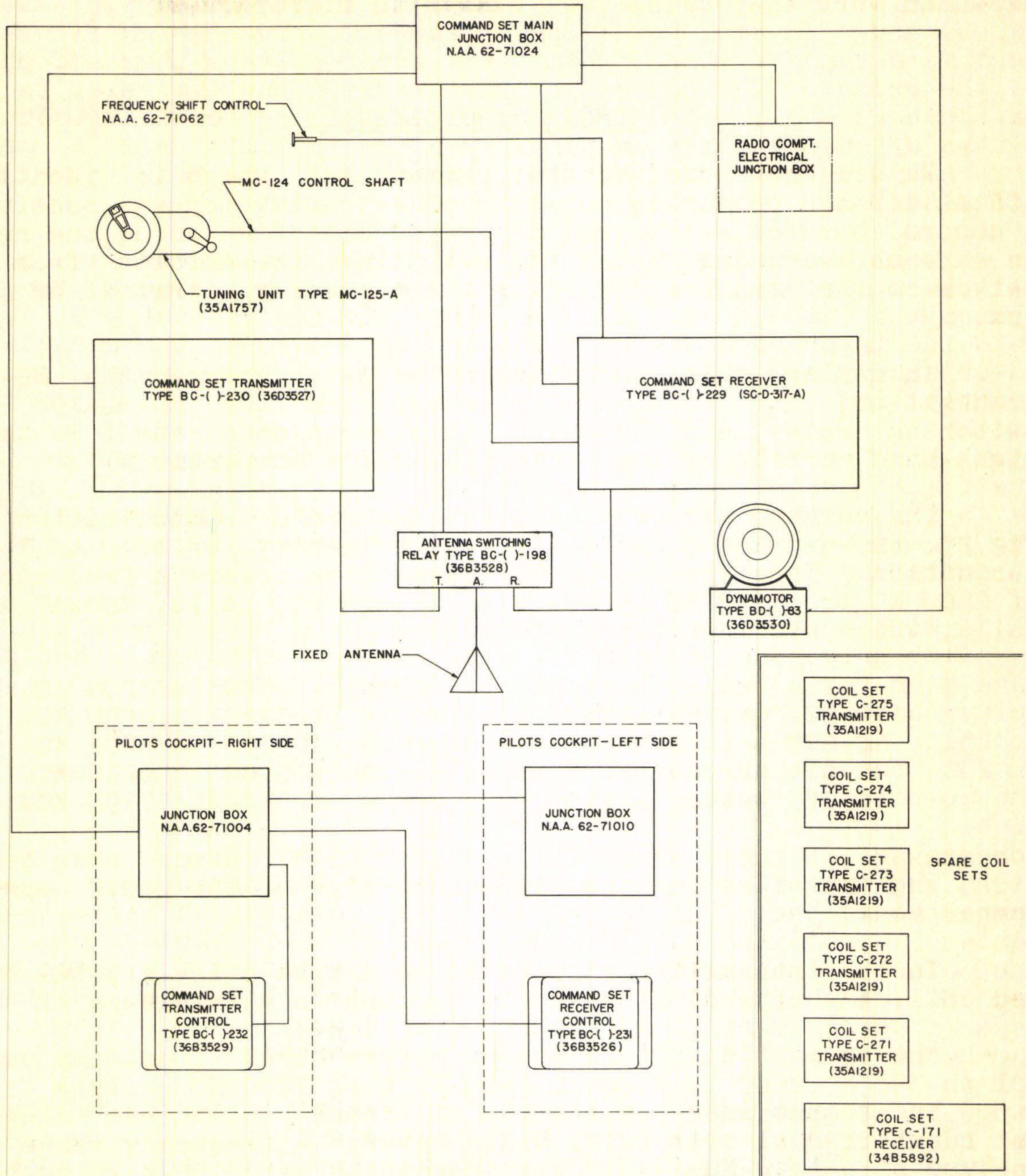


FIG. 23 SCHEMATIC DIAGRAM OF RADIO COMMAND SET (B-25, B-25A AND B-25B)

For interconnection of the command set units a terminal or junction box has been provided and is located over head in the radio operator's compartment, immediately above the command set shelf. In this junction box, in addition to the connector panel, will be found the transmit-receive relay, the 30 ohm 1/2 watt filter resistor, the .004 mfd. filter condenser,a 50 amp. main current supply fuse (Spec. 32084) and a 15 amp. fuse (Spec. 32084) through which filament current is drawn for the transmitter and receiver tubes and operation of the relays. The purpose of the transmit-receive relay is that of switching plate current from the plates of the receiver tubes to the plates of the transmitter tubes when the transmitter is in use; also the relay serves to connect the transmitter side tone into the interphone system.

The interphone wires paralleling the interphone jack boxes are all taken through the command set junction box where the command transmitter side tone and the command receiver output are connected into the interphone system. The interphone amplifier output and the power supply are also connected into the interphone system in this junction box.

Located between the transmitter and receiver and on the same shelf is the BC-AL-198 antenna switching relay, the function of which is, as the name implies, that of switching the antenna from the receiver to the transmitter or vice versa depending upon which is operating.

With control of the command set being vested in the pilot and co-pilot only, the mechanical and electrical command set controls have been installed in the pilot's cockpit. The type BC-AL-231 receiver control box is mounted on the left-hand side of the pilot's cockpit, adjacent to the pilot's aileron control wheel, and the BC-AL-232 transmitter control box is mounted on the right-hand side of the co-pilot's cockpit adjacent to the co-pilot's aileron control wheel.

The type MC-125-A command receiver tuning unit, commonly referred to as the "Coffee Grinder", is located substantially at the center line of the ship, on the under side of the cowling covering the pilot's instrument panel, and connected to the receiver by a type MC-124 shaft 300 inches long, routed back through the navigator's compartment on through the passageway over the bomb bay to the receiver in the radio operator's compartment.

Due to the length of shaft necessary to accomplish switching the receiver dual coil from high to low and low to high frequency, the use of a type MC-134 control shaft and type MC-135 control has been dispensed with and in lieu thereof, a type MC-137 local control has been reworked in order to accommodate the use of a commercial push-pull control (N.A.A. No. 62-71062), the push-pull knob of which is located on a structural frame over head and in back of the co-pilot's head. For the convenience of the user the knob is marked "COMM. REC. FREQ. SHIFT" "PULL HIGH-LOW PUSH".

The command set, both receiver and transmitter, is turned on

and off by a switch located on the front of the BC-AL-231 receiver control box. In addition to the position marked "OFF", there are two other positions which are marked "AUTO" and "MANUAL" the functions of which are as the marking indicates. With the switch turned to the "AUTO" position the command set is turned on and the receiver output is automatically controlled, while with the switch turned to the "MANUAL" position this output is manually controlled by the rheostat knob marked "INCREASE OUTPUT".

On the under side of the BC-AL-231 are located two phone jacks marked "TEL", both of which are connected in parallel and through which receiver signal and transmitter side tone signal may be heard in the headset from the command set only. These are not normally used due to the fact that the command set is connected into the interphone system, and transmission or reception may be accomplished from any of the eight interphone stations located throughout the ship.

The BC-AL-232 transmitter control box is used primarily for selecting the type of signal which the operator wishes to transmit. Markings on the front of the box -- "VOICE", "CW" and "TONE" -- clearly indicate the type of signal being transmitted. With the switch turned to the "VOICE" position, the microphone from the jack box switched to the command position will be operative and voice will be transmitted when the push-to-talk button is pressed, while the switch turned to the "CW" position a "continuous wave", or unmodulated signal will be transmitted, and with the switch turned to the "TONE" position a signal is transmitted which is 100 percent modulated at 1000 cycles. For long range communication through interference "CW" is most effective, "TONE" next, and "VOICE" least effective.

On both the CW and TONE positions, the microphone is inoperative on voice, and signalling by code is accomplished by a key which is located on the top of the transmitter control box. If so desired an external or separate key may be used by plugging same into the jack located on the under side of the box and marked "KEY". Adjacent to this jack marked "key" another jack will bé found which is marked "Mic" into which a microphone may be plugged by the operator who wishes to transmit voice over the command set only, rather than through the interphone system. If the operator so desires, the push-to-talk button on the microphone may be used as a key for transmitting code when the control box switch is turned to the "CW" or "TONE" position.

Should a change of frequency be desired which necessitates a change of insert coils, this change is accomplished by calling the radio operator on the interphone system and instructing him to replace the inserted coil with a coil of the desired frequency.

Tuning of the receiver or station selection is accomplished by the use of the tuning unit or "Coffee Grinder", on which is a dial having calibrated scales which match the insert coil in use. Do not attempt to tune the receiver with the receiver control switch turned

to the "AUTO" position; tune in the desired station with the switch set in the "MANUAL" position, then turn the switch to the "AUTO" position if automatic volume control is desired.

The type BD-AL-83 command set dynamotor is located under the radio operator's seat and is connected into the command and interphone system at the command junction box.

5. LIAISON SET GENERAL

We will not discuss the liaison set,Fig.24-25,which is identified as SCR-187-A and primarily consists of a transmitter with six interchangeable tuning units, a receiver, telegraph key, dynamotor, frequency meter, and the terminal or junction box, all of which are located in the radio operator's compartment and controlled by the radio operator only.

The function of the liaison set is for communication over comparatively long distances from ship to base,or ship to ground station, and it is used primarily for reporting ship position or flight progress.

The transmitter identified as BC-191 and the receiver identified as BC-224 are located on the left-hand side of the radio operator's compartment, immediately forward of the upper waist gunner's position on the B-25 and B-25A models, Fig. 24, while on model B-25B, Fig. 25, the same relative position has been maintained except due to the turret installation, the grouping has been shifted forward to a position immediately aft of the bomb bay.

The transmitter covers a frequency range of 1500 to 12,500 KC by the use of insert tuning units which are listed as follows:

TU-5A covering a frequency range of 1500 to 3000 KC.
TU-7A covering a frequency range of 4500 to 6200 KC.
TU-8A covering a frequency range of 6200 to 7700 KC.
TU-9A covering a frequency range of 7700 to 10000 KC.
TU-10A covering a frequency range of 10000 to 12500 KC.

Tuning unit TU-6A, covering a frequency range of 3000 to 4500 KC., is inserted in the transmitter by the contractor when the ship is delivered. Five cases, Type CS-48, have been provided for stowage of the spare tuning units and are located in the left-hand side of the radio operator's compartment.

On the face of each tuning unit is a chart which indicates the approximate dial settings for a desired frequency.

The output from the transmitter is carried through a bare copper wire connected to the transmitter antenna post at one end and to a terminal post provided on an antenna change-over switch at the other end.

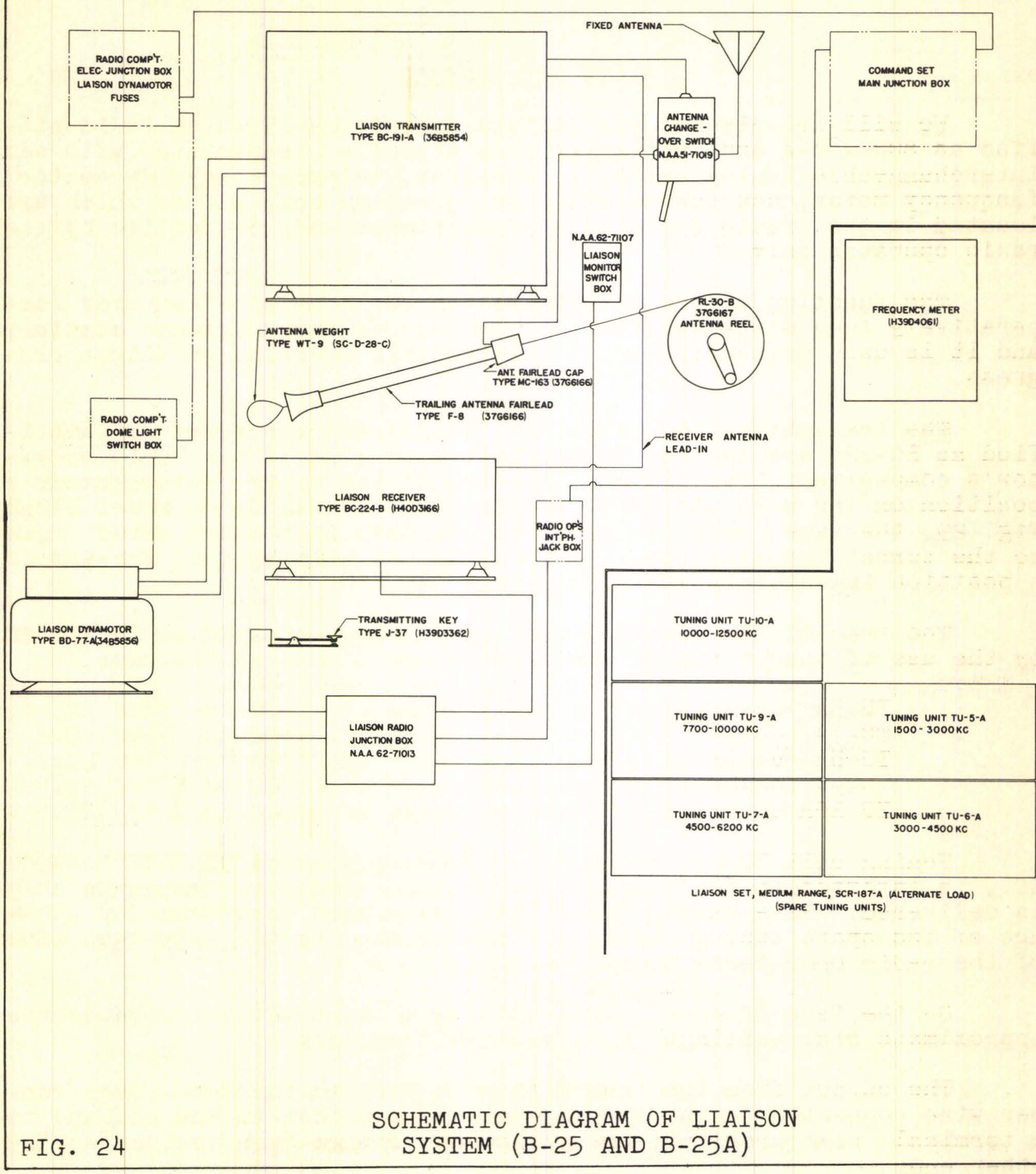


FIG. 24 SCHEMATIC DIAGRAM OF LIAISON SYSTEM (B-25 AND B-25A)

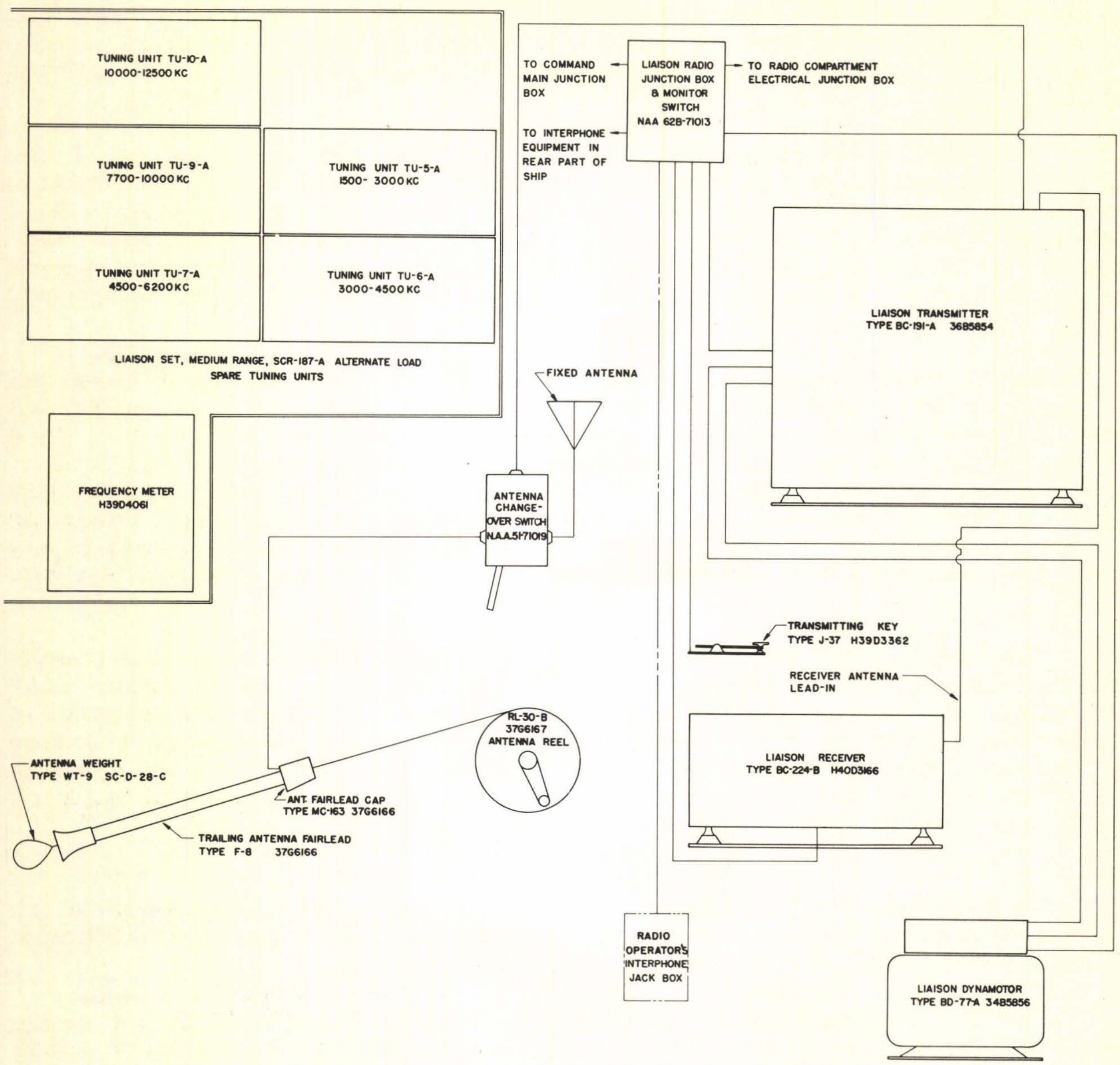


FIG. 25 SCHEMATIC DIAGRAM OF LIAISON SYSTEM (B-25B)

From the change-over switch the transmitter output is taken either to the trailing antenna or the fixed antenna.

The change-over switch (N.A.A. No. 51-71019), the purpose of which is to provide a means of switching the liaison equipment from the trailing antenna to the fixed antenna, is located on the left-hand side of the airplane in such a position that it may be conveniently reached by the operator. The switch handle extending from the bottom of the switch box is moved fore and aft, with antenna selection clearly indicated on a name plate attached to the cover of the box.

The BC-224 receiver is located on the left-hand side of the ship at the radio operator's writing desk, with the type J-37 transmitting key being located on the folding portion of the desk. This receiver contains a highly selective super-heterodyne circuit capable of voice, tone, or CW reception with manual or automatic volume control and has a frequency range coverage from 1500 KC to 18,000 KC.

For interconnection of the liaison set components a terminal or junction box has been provided and is located on the left-hand side of the radio operator's compartment under the receiver. This box contains terminals only, no fuses or other operating mechanism. This Liaison Junction Box location applies to B-25 and B-25A models only. On B-25B models the liaison junction box will be found on the left-hand side of the radio operator's compartment, immediately under the life raft compartment, and contains the MONITOR switch.

The monitor switch consists of two AN3015 switches the operating handles of which are connected together by a bar in order that they must be operated simultaneously. These switches are assembled on the box cover so that when the bar-connected operating handles are thrown from one position to the other, one switch is on and one is off in either position. The switch name plate carries the marking NORMAL for one position and MONITOR for the other position.

On B-25 and B-25A the monitor switch box, the purpose of which will be described under operation, is located on a bracket attached to the transmitter shelf and facing the operator.

For the purpose of adjusting the frequency indication of radio equipment to within very close limits,a type SCR-211 Frequency Meter has been provided and is located on a shelf on the left-hand side of the radio operator's compartment adjacent to the camera on B-25 and B-25A models. On B-25B models the frequency meter is located on a shelf on the right-hand side of the radio operator's compartment at the rear entrance of the passageway.

The liaison transmitter dynamotor with its necessary fuses and operating relay is located under the radio operator's seat adjacent to the command set dynamotor.

6. LIAISON SET OPERATION

The transmitter is turned on and off by a switch thus marked, located on the face of the transmitter case. With the transmitter turned on it is IMPORTANT that the filament voltage, as indicated on the meter marked FIL. VOLTAGE, be within close limits of the line on the face of the meter at 10 volts. The C.W. and modulator filament voltages are checked individually by a switch adjacent to the off-on switch.

Each tuning unit contains the necessary tuned circuits to permit a variable frequency transmitter output within the limits specified on the tuning unit in use. As stated before, located on the face of each tuning unit is a chart which indicates the approximate dial switch settings for a desired frequency. The calibration of these settings is quite close, but with the MONITOR SWITCH installation on these airplanes it is possible to tune the transmitter output frequency to exactly match the frequency of any station coming in over the receiver. With the monitor switch thrown to the MONITOR position, the side tone of the transmitter is antomatically cut off, and the receiver may be turned on with the CW switch on and adjusted to a desired frequency as indicated on the dial or to an incoming signal of a station which the operator desires to contact.The transmitter key is then pressed and the transmitter oscillator frequency dial adjusted until the transmitter frequency is heard in the receiver. Trim the transmitter adjustments for maximum output and re-check on the receiver. The transmitter will now be adjusted,and standing by ready for break-in on the station to which it has been adjusted.

With the monitor switch in the position marked NORMAL the receiver will be inoperative while the transmitter is operating, due to the transmit-receive relay cutting off screen grid voltage supply from the receiver tubes. The transmit-receive relay is located within the transmitter.

Microphone or voice input is delivered to the transmitter through only three interphone stations; pilot's,co-pilot's and radio operator's -- the other interphone stations not being connected to provide modulation of the transmitter. Receiver output, however, is delivered to any of the eight jack boxes which may be switched to the liaison or No. 2 position.

Do not attempt to make any internal adjustments, connect or disconnect any wires or bus bars, remove or replace any tubes or change any internal switches or fuses while the transmitter dynamotor is running.

The liaison receiver is turned on and off by a switch located on the front of the case, which in addition to having a position marked off has two other positions, marked MVC and AVC which means manual volume control and automatic volume control, respectively. Tuning or searching should be done with the switch turned to the MVC position and, after the desired signal has been tuned in, changed to

the AVC position if the operator so desires.

Band-switching or selection is accomplished by a knob thus marked and located on the face of the receiver case under the dial window. The band selected is indicated through the dial mask.

The receiver dynamotor is built into the receiver case with its output connections being made entirely within the unit.

7. RADIO COMPASS GENERAL

The radio compass, identified as SCR-273-A, Fig.26, generally speaking consists of a receiver; two remote control boxes; two right-left indicators; a rotatable loop; a loop direction indicator; a relay for shifting control; the necessary control shafting, and terminal or junction box.

The radio compass receiver unit, identified as BC-413-A, is a 12-tube super-heterodyne receiver having a frequency reception range of from 150 KC to 1500 KC. Considering the compass and liaison receivers it will be noted that this airplane has a continuous frequency reception coverage of from 150 KC to 18,000 KC.

The radio compass receiver, identified as BC-413-A, is located on the left-hand side of the forward entrance to the passageway over the bomb bay.

The two control boxes identified as BC-414-A, are located on the left-hand side of the ship;the pilot's control box being installed adjacent to the pilot's aileron control wheel, and the navigator's control box being installed forward of and below the navigator's window. The controls are mechanically connected by MC-124 shafts to an MC-203 tee coupling which in turn is mechanically connected by an MC-124 shaft to the compass receiver.

The loop antenna, identified as LP-19-A, is located outside and on top of the ship immediately over the navigator's compartment and is enclosed in a streamlined housing. The loop is mechanically connected through a type MC-204 control unit to a type I-75-A loop azimuth indicator by type MC-124 shafts. Electrical connection from the receiver to the loop is accomplished by a type CD-365 cord.

The two type I-65-C right-left indicators are located, one for the pilot on the pilot's instrument panel, and one for the navigator on a separate panel at the left of the main fuse panel junction box and over the navigator's chart table.

Interconnection of the various units is accomplished by use of the terminal posts provided on the face of the type KB-21-A relay, for which a housing or junction box has been provided and located on the left-hand side of the ship immediately aft of the navigator's window.

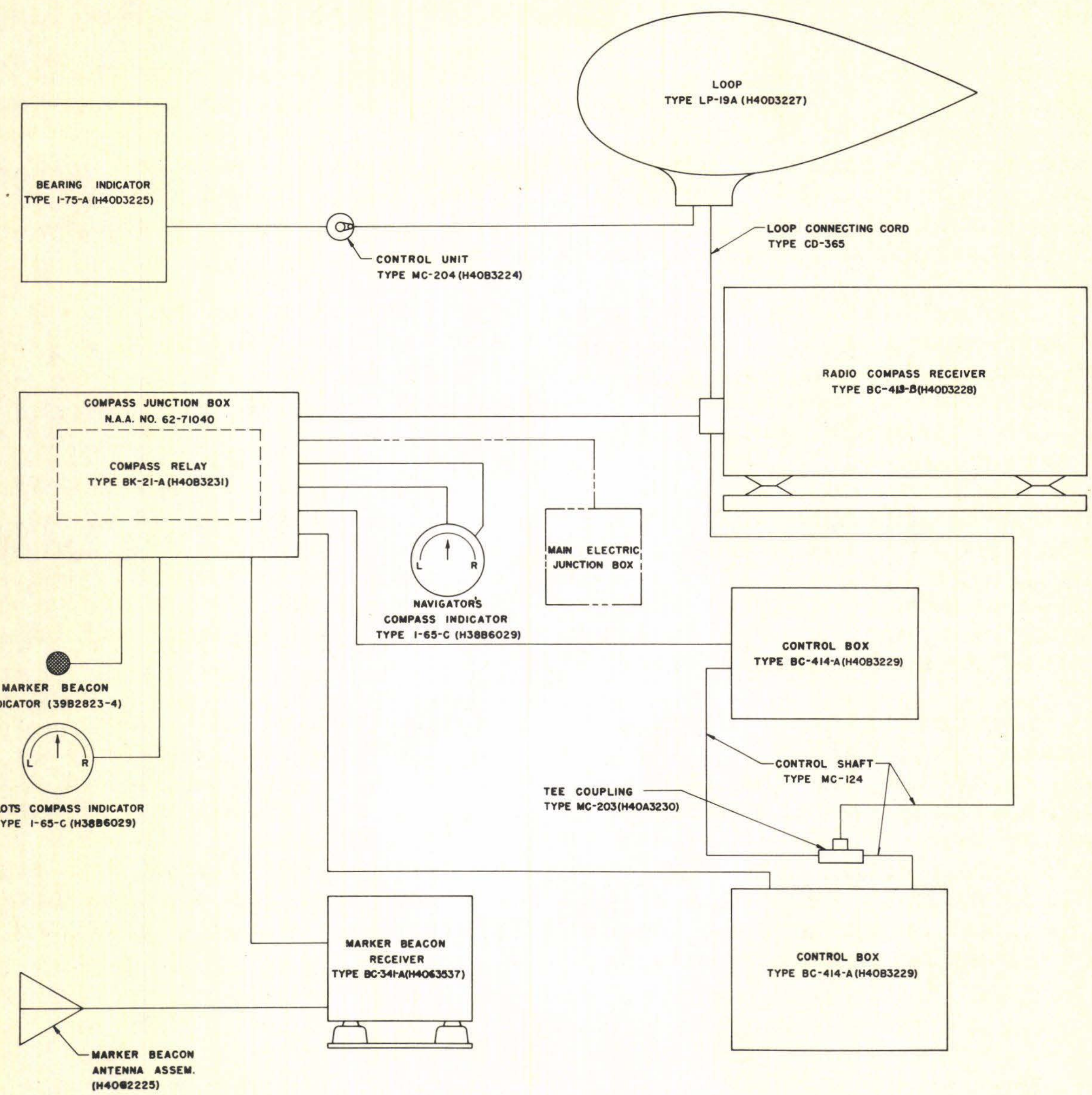


FIG. 26 SCHEMATIC DIAGRAM OF RADIO COMPASS SYSTEM (B-25, B-25A AND B-25B)

8. RADIO COMPASS OPERATION

The radio compass, Fig. 26, is operable from either of the two control boxes, but not both at the same time. The equipment is manually tuned from either remote control box and electrical control is established at the desired control box by depressing the button in the lower right-hand corner of the control box marked "CONTROL". When control is established at the desired remote control unit, a green indicating light will appear on the face of the control unit.

The radio compass equipment is designed to perform the following functions: (a) Give aural reception from the fixed antenna or from the rotatable loop. For signal reception during interference caused by precipitation static or proximity of signals,the loop will prove superior. (b) Aural-null directional indication of an incoming signal with the loop only in use. (c) Visual unidirectional left-right indication of an incoming signal.

The receiving unit is turned on or off by a switch on the face of the remote control box, which in addition to having an OFF position marked thereon has 3 other positions marked thus: COMP. ANT. and LOOP. With the switch turned to the position marked "COMP". both the rotatable loop and the fixed antenna are in use while with the switch turned to the position marked "ANT", only the fixed antenna is in use and with the switch turned to the position marked "LOOP" only the rotatable loop is in use. Band selection is accomplished by rotating the band switch to the frequency band in which operation is desired. The loop and loop azimuth indicator being both rotated simultaneously by the use of the type MC-204 control unit, it will be seen that the rotation of the loop in degrees may be read directly from the azimuth indicator.

For determining the position of the loop within its housing, a plunger or "DETENT" button has been provided in the base of the loop. Rotation of the loop with pressure applied to the detent plunger will allow the plunger to drop into or engage a slot in the rotating base of the loop, indicating that the loop is in zero position at this point (at right angle to the center line of the ship). The loop azimuth indicator should read zero position at this setting of the loop in order that the angular setting of both loop and indicator may be coincidental.

9. MARKER BEACON GENERAL

The marker beacon receiving equipment, identified as RC-39, Fig. 26, consists of a receiver, antenna, and an indicating or signal light.

The marker beacon equipment is designed to operate on 75 MC (ultra-high frequency) signals. Its purpose is to receive signals transmitted from instrument landing systems, fan stations, cone of silence stations, and other facilities employing 75 MC horizontally polarized transmission patterns.

The marker beacon equipment relies entirely on the compass equipment for its power supply, and is, therefore, interconnected to the compass equipment through a conduit extending from the marker beacon receiver to the compass junction box.

The marker beacon receiver, identified as type BC-341, is located on the left-hand side of the navigator's compartment floor immediately forward of the map case where it may be easily reached for adjustment or maintenance.

The marker beacon indicator, identified as 39B2823-4 and located on the pilot's instrument panel, is a signal lamp having an amber jewel cover and equipped with a 14-volt .15-amp. bayonet base type T-3 1/4 lamp.

The marker beacon antenna transmission line WC-358 is routed from the receiver forward under the floor to a fitting provided in the under side of the ship.

10. MARKER BEACON OPERATION

The operation of the marker beacon equipment being fully automatic, there is no manual operation required.

As the ship passes over a fixed point from which a marker signal is being transmitted, the signal is picked up by the receiver the output of which actuates a built-in relay. This relay in turn causes the indicator to flash on, thus indicating to the pilot that he has passed over a marker beacon.

11. ANTENNA SYSTEM

The antenna system, Fig.27, consists of five separate antennae made from type W-106-A wire. Each antenna has a separate and distinct function with relation to the equipment installed in the airplane.

Three of these fixed antennae use a common mast at their forward point of attachment, the mast being located on the top of the ship immediately aft of the pilot's compartment.

The command set antenna is a TEE type antenna which extends from the forward common mast, aft to an attaching clip located on the inner top side of the right-hand vertical stabilizer. The lead-in extends from the antenna to a type IN-79 insulator located in the right-hand side of the ship adjacent to the command set antenna switching relay.

The liaison fixed antenna is a TEE type antenna which extends from the forward common mast, aft to an attaching clip located on the inner top side of the left-hand vertical stabilizer. The lead-in extends from the antenna to a type IN-84 insulator located in the

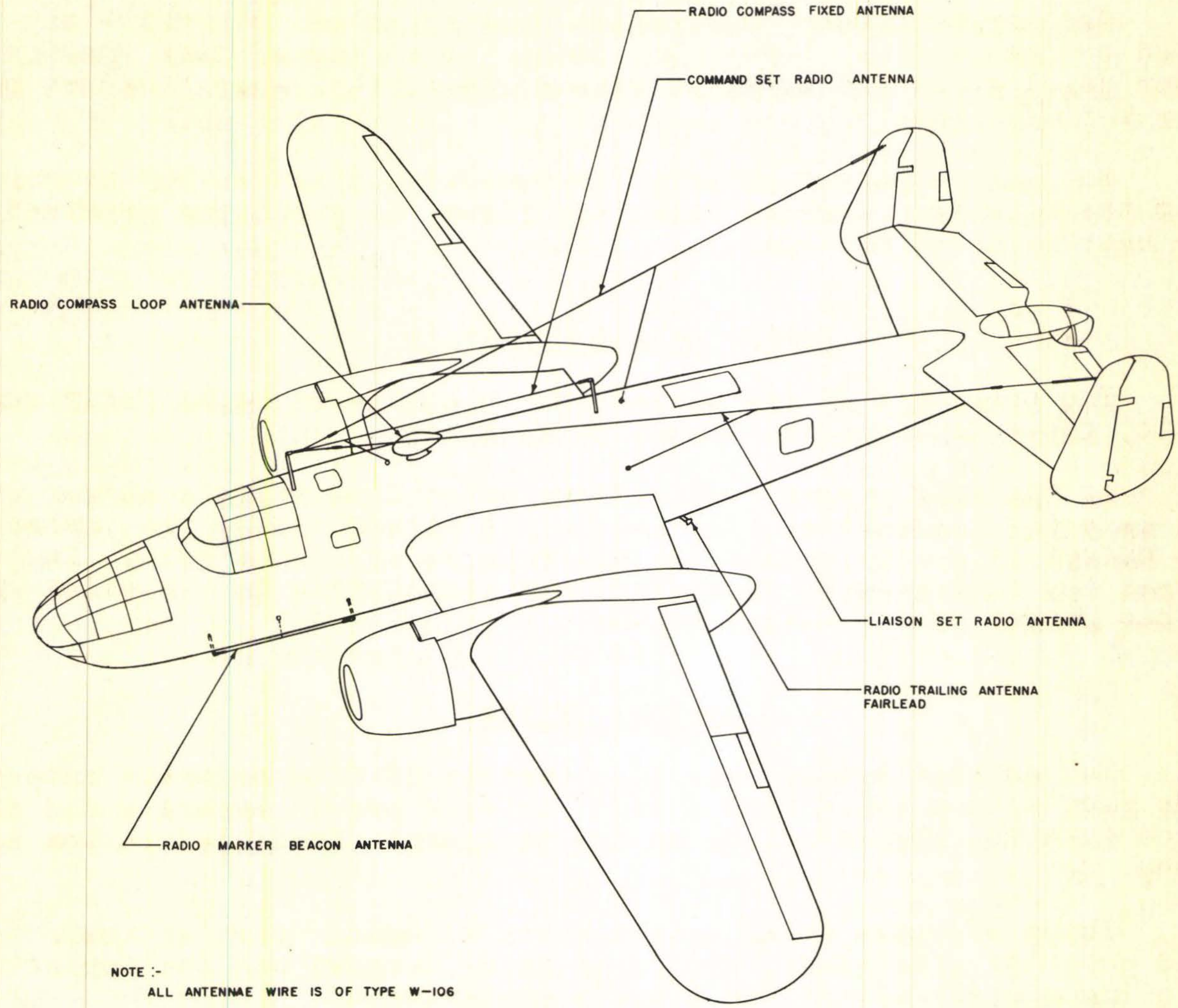


FIG. 27 RADIO ANTENNA INSTALLATION (B-25, B-25A AND B-25B)

left-hand side of the ship, adjacent to the liaison change-over switch (Reference Technical Order 08-5-2A).

The radio compass fixed antenna is an inverted L type antenna which extends from the forward common mast to a mast located on top of the ship at the rear of the bomb bay. The lead-in extends from the antenna to a type IN-79 insulator located on the ship immediately forward of the loop. A shock link has been installed near the rear point of attachment in the liaison set and command set antennae. Insulation has been accomplished by the use of type IN-88 strain insulators at each point of attachment.

The contractor has established an initial tension of 15 lbs. in the command and liaison antennae and an initial tension of 10 lbs. in the compass fixed antenna.

The marker beacon antenna is located on the under side of the ship adjacent to the nose wheel landing gear, and has been designed and installed in accordance with Air Corps Drawing No. H40G2225. There being no shock link used in the marker beacon antenna, an initial tension of 3 to 5 pounds is sufficient.

The liaison trailing antenna is wound on a type RL-30-B reel which is located on the left-hand side of the radio operator's compartment, conveniently accessible for operation. The W-106 wire is fed from the reel through a phenol fibre tube fairlead over a pulley enclosed in a cast elbow to the type F-8 fairlead where a type WT-7-A antenna weight is attached. Reeling in the trailing antenna is accomplished by turning the handle of the reel in a clockwise direction; paying out or releasing the trailing antenna is accomplished by moving the handle of the reel in a counter-clockwise direction, thus releasing the built-in brake.

12. GENERAL RADIO OPERATION

Radio operation, being of highly specialized nature, especially the radio compass equipment in its relationshio to navigation, no attempt has been made in this discussion to give detailed instruction on this subject.

Persons unfamiliar with the radio equipment,should not make an attempt to operate any of the equipment until a thorough study of the Books of Instructions has been made. The Books of Instructions are stowed in the data case in the radio operator's compartment. (Reference Technical Order 08-5-2).

13. TROUBLE SHOOTING

Failure of the radio equipment to function when turned on should be checked first at the source of current supply to the particular unit involved. For the convenience of those whose duty it is to replace "blown-out" fuses, a chart, Fig.28, has been pre-

APPLICATION	ACTIVE FUSE LOCATION	SPARE FUSE LOCATION	FUSE CAPACITY
COMMAND SET MAIN SUPPLY FILAMENT SUPPLY	COMMAND SET JUNCTION BOX	JUNCTION BOX COVER	50 AMP 15 AMP
INTERPHONE SAME AS COMMAND SET			
* LIAISON SET DYNAMOTOR TRANSMITTER	ELEC. JUNCTION BOX FWD. OF LIFE RAFT	JUNCTION BOX COVER	100 AMP 35 AMP
COMPASS	COMPASS JUNCTION BOX	JUNCTION BOX COVER	15 AMP
MARKER BEACON SAME AS COMPASS			

* APPLIES TO B-25 & B-25A ONLY. NO EXTERNAL FUSES INSTALLED FOR B-25B LIAISON SET.

ALL FUSES ARE SPEC. 32084.

THIS CHART DOES NOT LIST FUSES WHICH ARE BUILT INTO GOVERNMENT FURNISHED EQUIPMENT.

FIG. 28 RADIO FUSE CHART (B-25, B-25A AND B-25B)

pared giving the application, active fuse location, spare fuse location and amperage capacity of all fuses applicable to the radio system which have been furnished and installed by the contractor.

For fuse capacities and locations of fuses built into the government furnished equipment, the instruction book applicable to the unit in question should be consulted.

Current supply proving active at the initial source but inactive at its entrance to the unit involved, indicates that a continuity check of the wiring should be made. Defective wires, if any, should be replaced in their entirety with wires of the same gauge as those which they replace. For the convenience of the personnel making such continuity checks, a chart has been installed in the junction box covers showing the terminal connections of wires within the box.

Inoperative government furnished equipment should be checked in accordance with the instructions given in the Book of Instructions applicable to the unit involved. Inoperative units which cannot be made operative by tube replacement or internal fuse replacement, or by very minor repairs, should be replaced with units known to be operative and the defective unit routed through the usual Air Corps channels for repair.

Marker Beacons } 110 Volt - 400 Cycle A.C. - from inverters
Radio Compass }

Interphone System - 250 Volts D.C. - Interphone dynamotor

Command Set - 500 volts D.C. - Command dynamotor

Liaison Set - 1000 Volts D.C. - Liaison dynamotor

Command Set - 2 trans. 3 rec. upper right nav. comp.
(Ship to ship)

Liaison Set - 1 trans, 1 rec. telegraph key, 8 interchangable tuning units, dynamotor, frequency meter, antenna tuning unit, terminal or junction box. - Radio operators compartment.
Ships to base, ship to ground.

Radio Compass - 1 rec. 2 remote control boxes, r. l. indicator, rotatable loop, loop dir. indicator, relay control shafting, junc box terminal. Left side of forward entrance bomb bay crawl deck.
Loop direction

Marker Beacon - 1 rec. antenna, indicating light
Receives signals from directional ground stations

Interphone - 1 interphone amplifier, 8 jack boxes,
Interphone communication on ship

TRUMENT
INSTALLATION

NORTH AMERICAN AVIATION Inc.

Instrument Install. LECTURE

B-25 SERIES AIRPLANES

PREPARED BY The Field Service Department

NOTE

THE INFORMATION CONTAINED IN THIS LECTURE WAS CORRECT AS OF MAY 15, 1942. REFER TO HANDBOOK OF OPERATION AND SERVICE INSTRUCTIONS FOR THE LATEST INFORMATION.

INGLEWOOD, CALIFORNIA

INDEX

INDEX (Continued)

ILLUSTRATIONS

ADDENDUM

GENERAL AIRPLANE

The Model B-25C and B-25D Bombardment Airplanes are high speed, mid-wing land monoplanes, powered by two double-row Wright Cyclone R-2600-13 engines. The engines drive three-blade propellers of the hydromatic controllable, full feathering type. Hydraulically operated tricycle type landing gear, wing flaps, bomb bay doors, cowl flaps and brakes are provided. An emergency mechanical method of operation for all hydraulically operated units, except engine cowl flaps, is provided. The normal combat crew of five consists of a pilot, co-pilot, bombardier, combined radio operator and lower turret gunner and an upper turret gunner; however, seats are provided for a crew of six. Interchangeability of all members of the crew during flight can readily be accomplished by using passageways over the bomb bay or under the pilot's seat. The airplanes are finished with camouflage.

FUSELAGE

The fuselage is a semi-monocoque, four longeron, stressed skin structure. The bombardier's, pilot's and navigator's compartments are located from the nose of the fuselage to the bomb bay. The radio operator and turret gunners are located from the bomb bay to the rear entrance hatch. The camera station is located just aft of the rear entrance hatch. There is a tail look-out station provided just aft of the camera station. An armor plate bulkhead and door is installed just forward of the rear entrance hatch and separates the radio-gun compartment from the camera compartment. The fuselage is adequately sound proofed.

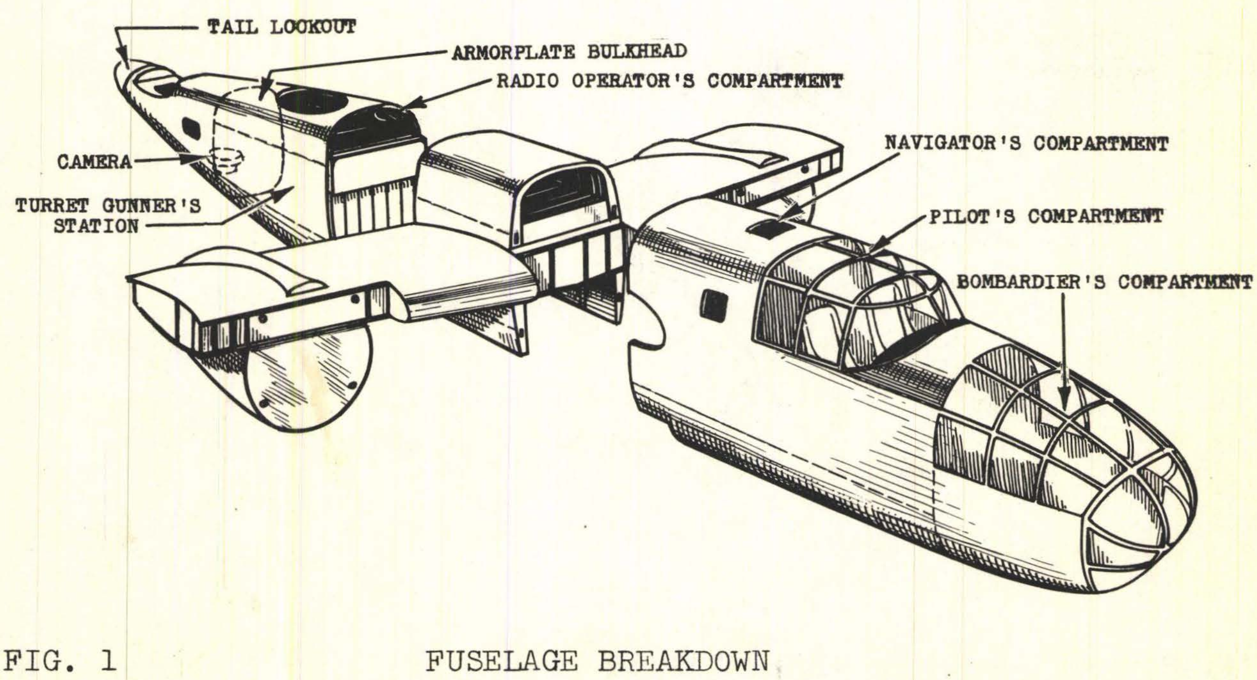


FIG. 1 FUSELAGE BREAKDOWN

WING

The mid-wing is a full cantilever, stressed skin structure, consisting of a two-spar center section permanently attached to the fuselage, and two removable single spar outer panels provided with detachable tips. The ailerons are of the sealed type and are equipped with combination booster and controllable trim tabs. Hydraulically operated trailing edge flaps of the slotted type extend from the fuselage sides to the engine nacelles and from the nacelles to the ailerons. When the flaps are lowered, a fairing door mechanically interconnected with the flaps hinges upward into the trailing edge of the wing to form a continuous slot opening. A landing gear and flap position indicator instrument is provided on the pilot's instrument panel. The power plant assemblies are supported on the forward side of the center wing front spar and the engine nacelle. Self-sealing oil compartments are anintegral part of the wing center section structure. The fuel is carried in self-sealing gas cells in the center wing just inboard of the nacelles. Access to these cells is gained by removing tank doors from lower surface of center wing. WARNING: Each fuel cell is covered by one large tank door. Separate, mechanically sealed compartments are provided in the outer wing panels and center section to provide temporary flotation. Bilge equipment is not provided.

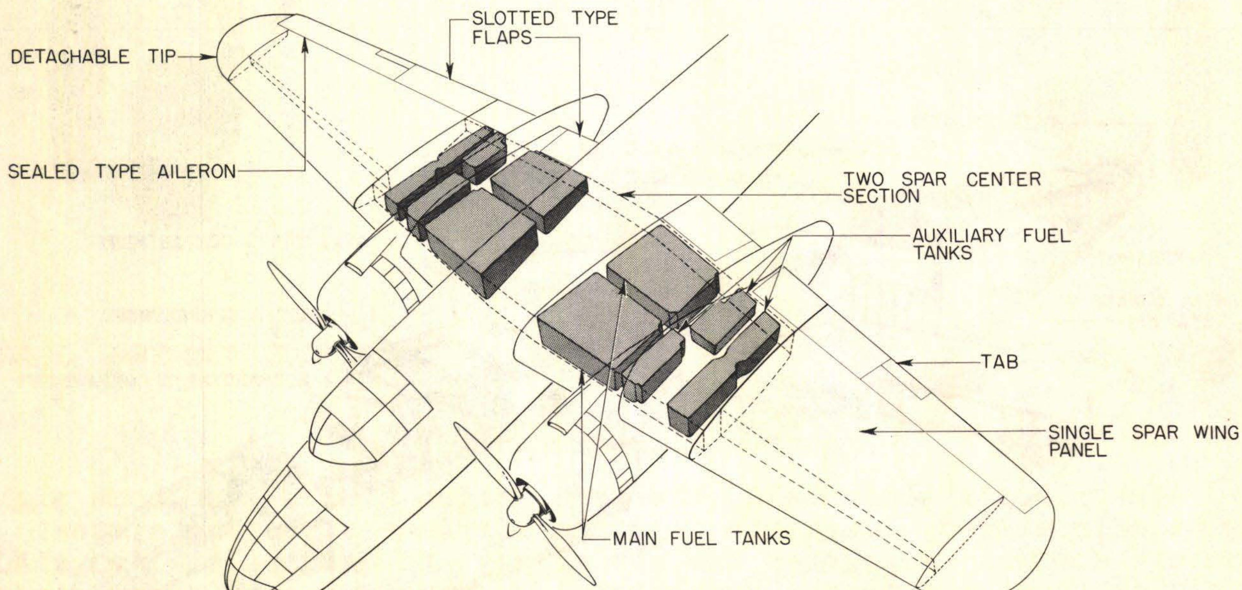


FIG. 2 WING ASSEMBLY

EMPENNAGE

The empennage is of the double fin and rudder design. The stabilizers are full cantilever structures and are nonadjustable. The elevators are equipped with combination booster and controllable trim tabs.

LANDING GEAR

A fully retractable, hydraulically operated, tricycle type landing gear and fixed tail skid are provided. The landing gear components retract aft; the main gear into the engine nacelles, and the nose gear ~~and tail skid~~ into the fuselage. Doors cover the gear openings in both the retracted and extended positions. The nose gear is of the swivel type and incorporates a centering device, which is operative when the strut is fully extended. A hydraulic shimmy damper is provided on the strut to resist sudden side loads occurring in taxying. An automatic metering device, incorporated in the damper, allows the wheel to be turned by the thrust of one engine and the braking of the opposite wheel. A release is provided on the strut for towing purposes and a static ground wire is attached to the wheel assembly.

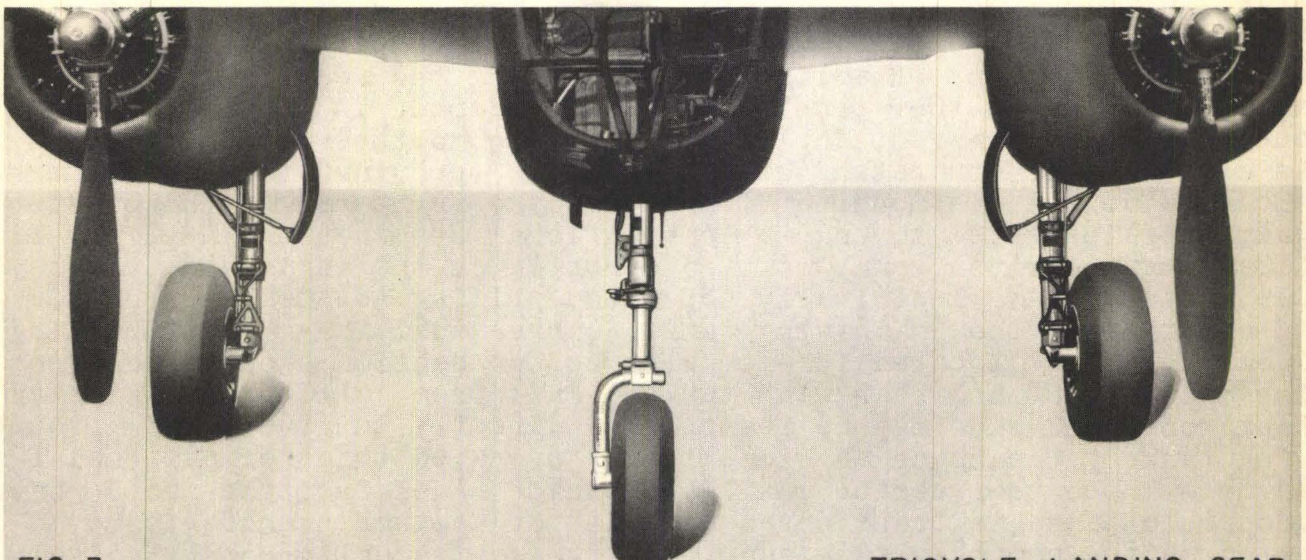


FIG. 3 TRICYCLE LANDING GEAR

DEFROSTING SYSTEM

The pilot's windshield, the bomb sight window and bomb sight may be defrosted by warm air from the airplane's heating system. A separate control regulates the air supply to each of the two windshield sections and to the bomb sight, whereas the bomb sight window receives heat whenever the airplane's system is in operation.

HEATING AND VENTILATING SYSTEM

A Stewart-Warner, gasoline vapor burning type of heater is pro-

vided. The system consists essentially of the heater unit in the left wing center section nose and the necessary ducts and valves. A control is provided in the left rear corner of the navigator's compartment for regulating the output of the heater. In the off position only cold air enters the ducts, in any other position heated air of varying temperatures enters the ducts. In addition to the above, controllable cold air scoops are provided for the pilot, co-pilot and bombardier.

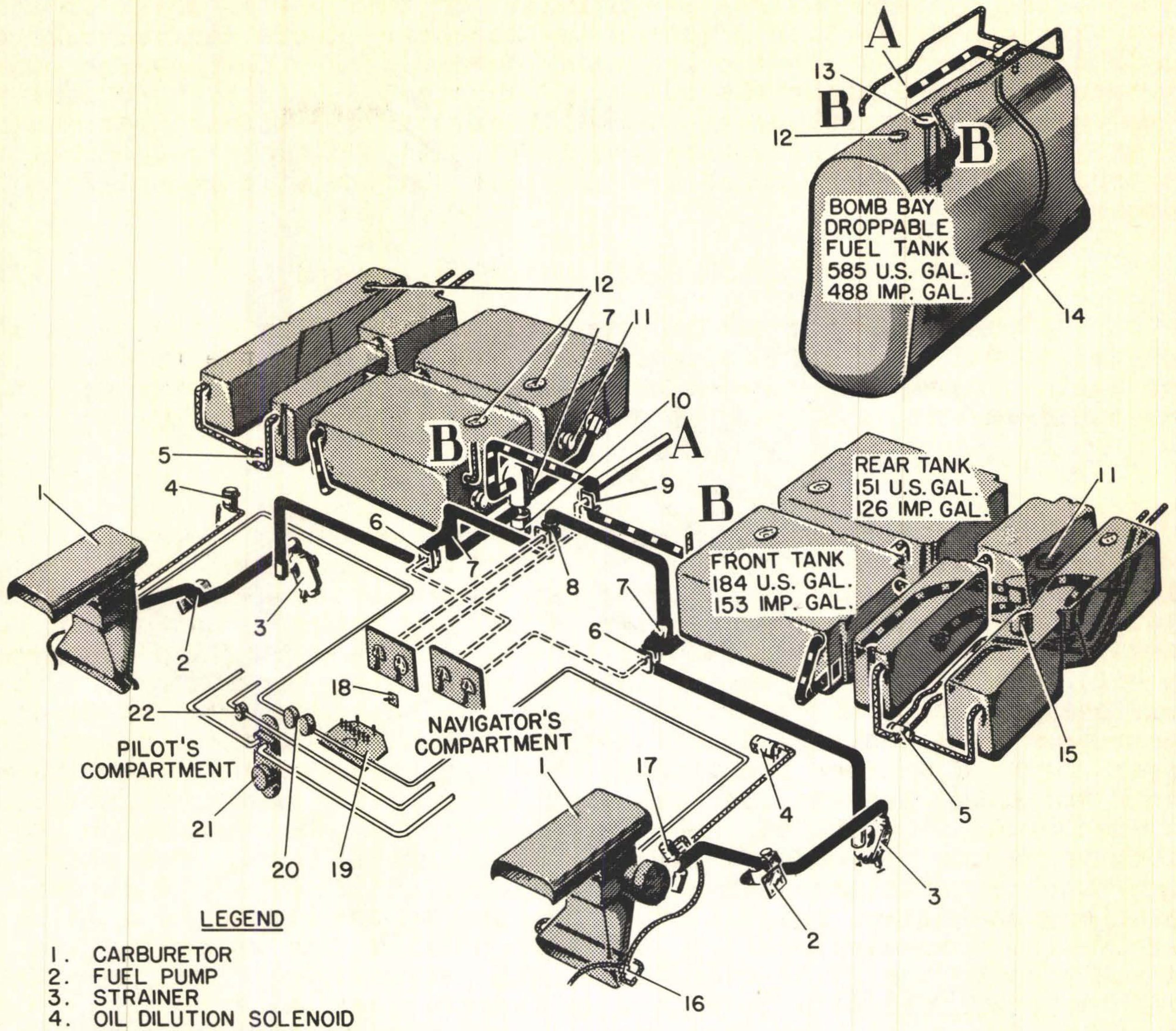
POWER PLANT CONTROLS

The power plant controls consist of cables from the pedestal to the firewall and conventional push-pull rods from the firewall to the engine, except for propeller control which is cable throughout. The controls are operable from the pilot's compartment only.

FUEL SYSTEM

Each engine is provided with an independent fuel system. On B-25C airplanes, Serial Nos. AC 41-12817 and subsequent and B-25 D airplanes, Serial Nos. AC 41-29848, and subsequent, a fuel transfer system with electrically operated auxiliary transfer pumps and a manually controlled cross-feed shut-off valve are provided as shown in Fig. 4. Wing fuel tanks, transfer and feed lines are of the self-sealing type. The two main wing fuel compartments are interconnected by means of a line extending from the rear tank to an adapter mounted on the front tank. The adapter is provided with a check valve to prevent fuel from returning to the rear compartment. An electrically operated booster pump is provided forward of the check valve and is mounted directly to the front tank. The booster pump supplies fuel through a conventional strainer on the firewall to an engine-driven pump mounted directly on the engine to a Holley Carburetor. An electrically operated priming system is provided. In addition to the main wing tanks, three auxiliary self-sealing fuel tanks are located in each wing center section, outboard from the main front and rear wing tanks. Fuel from all three auxiliary tanks on each side may be transferred directly to the main front wing tank by means of an electrically operated transfer pump mounted below the rear center auxiliary tank. Fuel from the bomb bay droppable tank is transferred by means of another transfer pump located on the bomb bay tank sump. A two-way manually operated selector valve directs fuel from the bomb bay droppable tank to either the right or left front wing tank. No provisions are made to return fuel from the above listed airplanes to the bomb bay tank. A cross-feed line provided with a manually operated shut-off valve makes it possible for the booster pump of either front wing tank to supply fuel to the opposite engine fuel pump. A check valve is provided to prevent fuel in the cross-feed line from flowing back into the wing tanks. A hand pump is also provided for use in case the electric pump should fail, and is located in rear of navigator's compartment.

On these airplanes a liquidometer is provided on the pilot's instrument panel which will give four selective readings for fuel



LEGEND

1. CARBURETOR
2. FUEL PUMP
3. STRAINER
4. OIL DILUTION SOLENOID
5. DRAIN AND VENT RELIEF VALVE
6. EMERGENCY FUEL SHUT-OFF VALVE
7. CHECK VALVE
8. CROSS-FEED SHUT-OFF VALVE
9. BOMB BAY DROPPABLE TANK TRANSFER VALVE
10. BOOSTER PUMP
11. LIQUIDOMETER FUEL GAUGE UNIT
12. FILLER CAP
13. BOMB BAY TANK FUEL GAUGE
14. BOMB BAY TANK TRANSFER PUMP
15. AUXILIARY WING TANKS TRANSFER PUMP
16. PRIMER DISTRIBUTOR
17. PRIMER SOLENOID
18. BOMB BAY TANK TRANSFER PUMP SWITCH
19. CONTROL PEDESTAL SWITCH PANEL
    BOOSTER PUMP SWITCHES
    AUXILIARY TRANSFER PUMP SWITCHES
    PRIMER SWITCH
20. FUEL PRESSURE GAUGES
21. MAIN TANK SELECTIVE LIQUIDOMETER INDICATOR
22. AUXILIARY WING TANK LIQUIDOMETER INDICATOR

LINE CODE

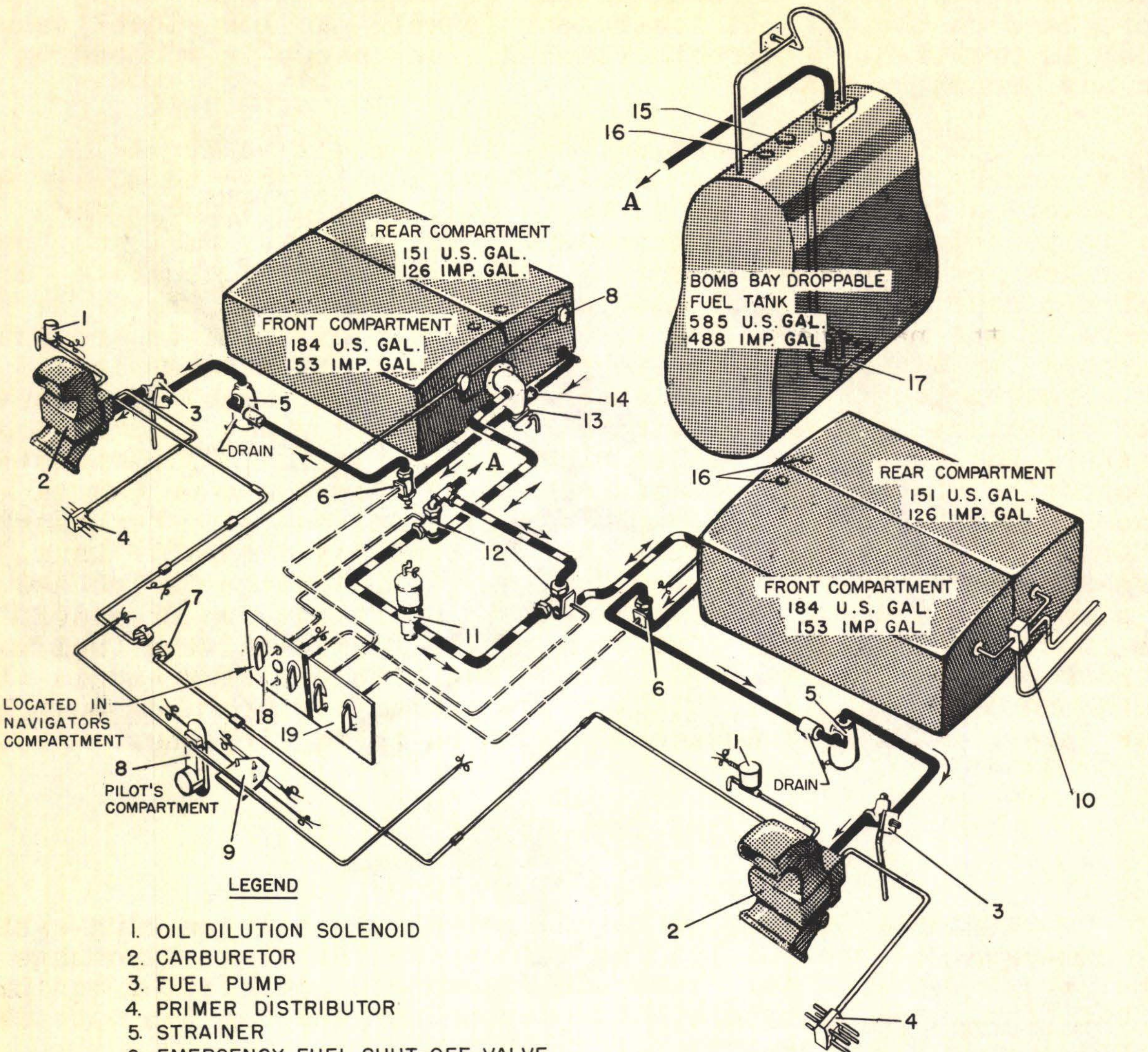
MAIN LINES
TRANSFER LINES
VENT AND DRAIN LINES, PRIMER AND OIL DILUTION LINES.
CONTROL RODS
ELECTRICAL CONDUIT

NOTE

TOTAL CAPACITY OF SIX AUXILIARY WING TANKS IS APPROXIMATELY 300 U. S. GAL. (250 IMP. GAL.).

FUEL HOSES AND FUEL TANKS (EXCEPT BOMB BAY TANK) ARE SELF-SEALING.

FIG. 4 FUEL SYSTEM DIAGRAM - 384th and SUBSEQUENT



LEGEND

1. OIL DILUTION SOLENOID
2. CARBURETOR
3. FUEL PUMP
4. PRIMER DISTRIBUTOR
5. STRAINER
6. EMERGENCY FUEL SHUT-OFF VALVE
7. FUEL PRESSURE GAUGES
8. LIQUIDOMETER FUEL GAUGE UNITS
9. CONTROL PEDESTAL SWITCH PANEL
   BOOSTER PUMP SWITCHES
   PRIMER SWITCH
10. DRAIN AND VENT VALVE
11. TRANSFER PUMP
12. TRANSFER VALVE
13. BOOSTER PUMP
14. CHECK VALVE
15. FUEL GAUGE (FLOAT TYPE)
16. FILLER FLANGE
17. SUMP
18. FUEL TRANSFER CONTROLS
    PUMP SWITCH
    DIRECTIONAL FLOW SWITCH
    PUMP OPERATING LIGHT
19. EMERGENCY SHUT-OFF VALVE CONTROLS

LINE CODE

- MAIN LINES
- TRANSFER LINES
- VENT, DRAIN & OTHER LINES
- CONTROL RODS
- ELECTRICAL WIRING AND CONDUIT

NOTE:
FUEL CAPACITY ON SOME AIRPLANES IS { 12 U.S. GAL. LESS / 10 IMP. GAL. LESS

FUEL TANKS AND HOSE ARE SELF SEALING

FIG. 5 FUEL SYSTEM DIAGRAM - B-25C

in each of the four main fuel tanks. In addition, a separate liquidometer fuel level in each group of three auxiliary wing tanks is provided on the pilot's instrument panel. No low level warning signal is provided. A direct reading fuel gauge is mounted on the bomb bay droppable tank.

On B-25C airplanes, Serial Nos. AC 41-12434 to AC 41-12816 inclusive and B-25D airplanes, Serial Nos. AC 41-29648 to AC 41-29847 inclusive, a fuel system as shown in Fig. 5 is provided. Each engine is provided with an independent fuel system. Fuel and transfer lines are of the self-sealing type. The system consists of a front and rear fuel compartment mounted in the wing center section inboard of the nacelles. The two wing fuel compartments are interconnected by a check valve to prevent fuel from returning to the rear compartment. A fuel transfer system, with manually operated selector valves and an electrically operated pump, is provided to transfer the fuel from either right or left fuel compartments to the opposite front fuel compartment, or from the bomb bay tank to either right or left fuel compartments. Fuel may also be transferred from the front wing tanks to the bomb bay droppable tank. On these airplanes a liquidometer fuel gauge indicator is located on the pilot's instrument panel. Selector positions are provided to give fuel level readings for each of the four main wing fuel tanks. A direct reading gauge is mounted on the bomb bay tank and is visible through the manhole located on the passageway over the bomb bay. A low level fuel signal is not provided on these airplanes.

DE-ICER SYSTEM

Conventional de-icer shoe and propeller slinger ring systems are employed to prevent ice formations on the wing, empennage and propellers. Conventional warm air windshield defrosting equipment has been supplemented by a special device for coating the outside of the windshield with ice-preventing fluid.

OIL SYSTEM

An independent oil system, Fig. 6, is provided for each engine. Each system consists essentially of an oil compartment and two automatic temperature indicators. The temperature regulators are connected in parallel at the root of each outer wing panel and are equipped with manually operated shutters. The oil cooler shutter control system is spring-loaded in order that the shutters will automatically assume an open position if a control cable or rod becomes disengaged by gunfire or malfunctioning. Each oil compartment as well as oil supply lines are of the self-sealing type. This applies to B-25C airplanes, Serial Nos. AC 41-12817 and subsequent and B-25D airplanes, Serial Nos. AC 41-29848 and subsequent. On earlier models of the B-25C and B-25D airplanes, the oil compartment was built semi-integral with the center wing, directly aft of the firewall and equipped with a hopper to accelerate warming of the oil.

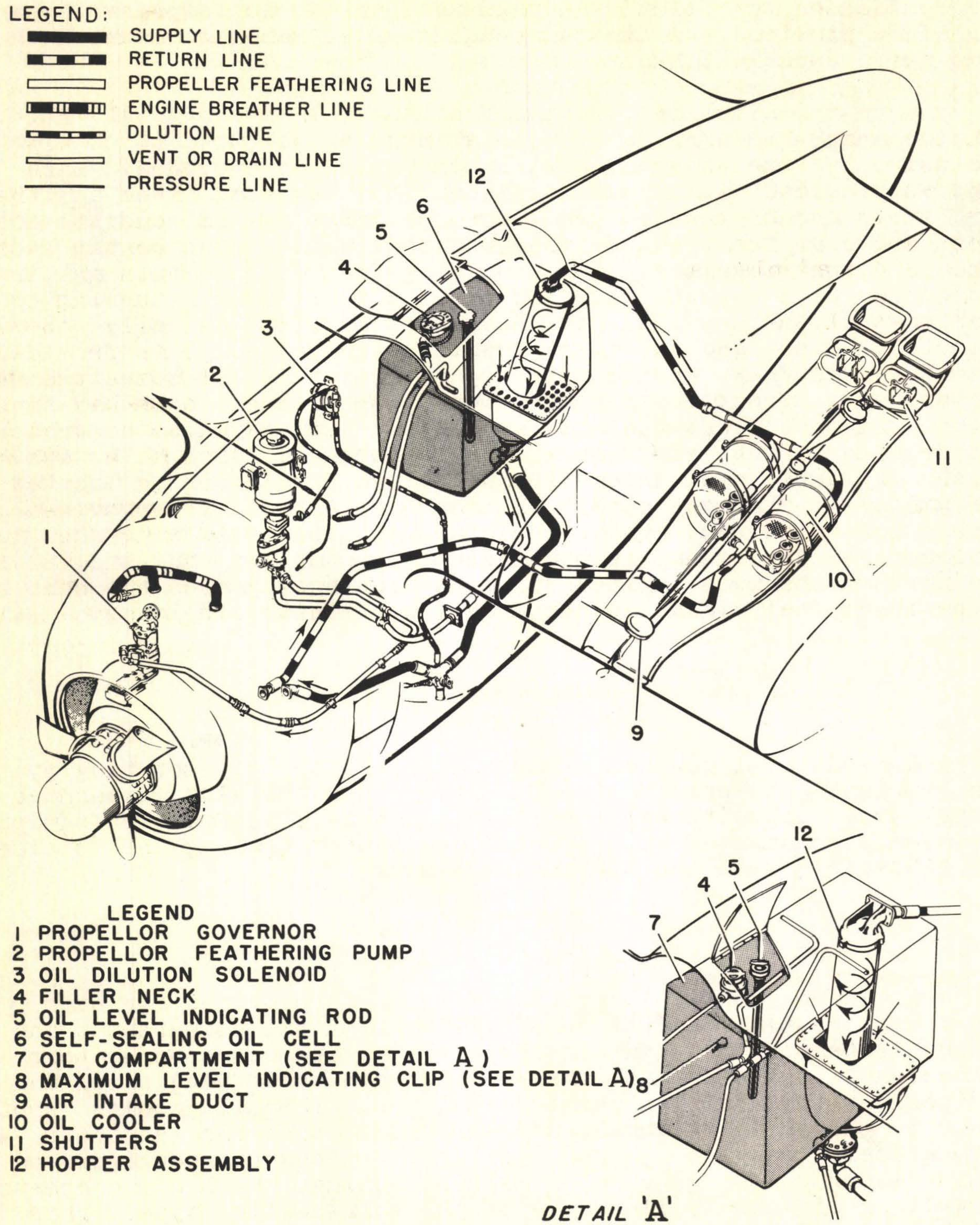


FIG. 6 OIL SYSTEM DIAGRAM

DOOR LOCKS

Cabinet type locks are provided for the bomb sight stowage case and the front and rear entrance hatches. A padlock is provided for the bomb sight stabilizer cover and for the A.F.C.E. or Sperry Automatic Pilot covers. In the case of the entrance hatches the purpose of the lock is to lock the handle plate only, and not the mechanism. This allows the doors to be opened from inside the airplane whether they are locked or not. All the above locks are operated by the same key, two of which are supplied with each airplane. The keys are not interchangeable between airplanes, but one master key is provided for every six airplanes, which will open all the locks on any of the airplanes.

SEATS

The pilot's and co-pilot's seats are conventional and may be adjusted both horizontally and vertically. The bombardier is provided with an adjustable motorcycle type bomb sight seat and a folding riding seat. The bomb sight is removable and may be stowed by means of bracket and strap provided at right side of riding seat. The navigator is provided with a folding stool for chart board work, and the chart board when folded back becomes the navigator's riding seat. Retractable footrests are provided for use in conjunction with navigator's riding seat. A folding seat is also provided for the radio operator. The seats and rests for the gunners are an integral part of

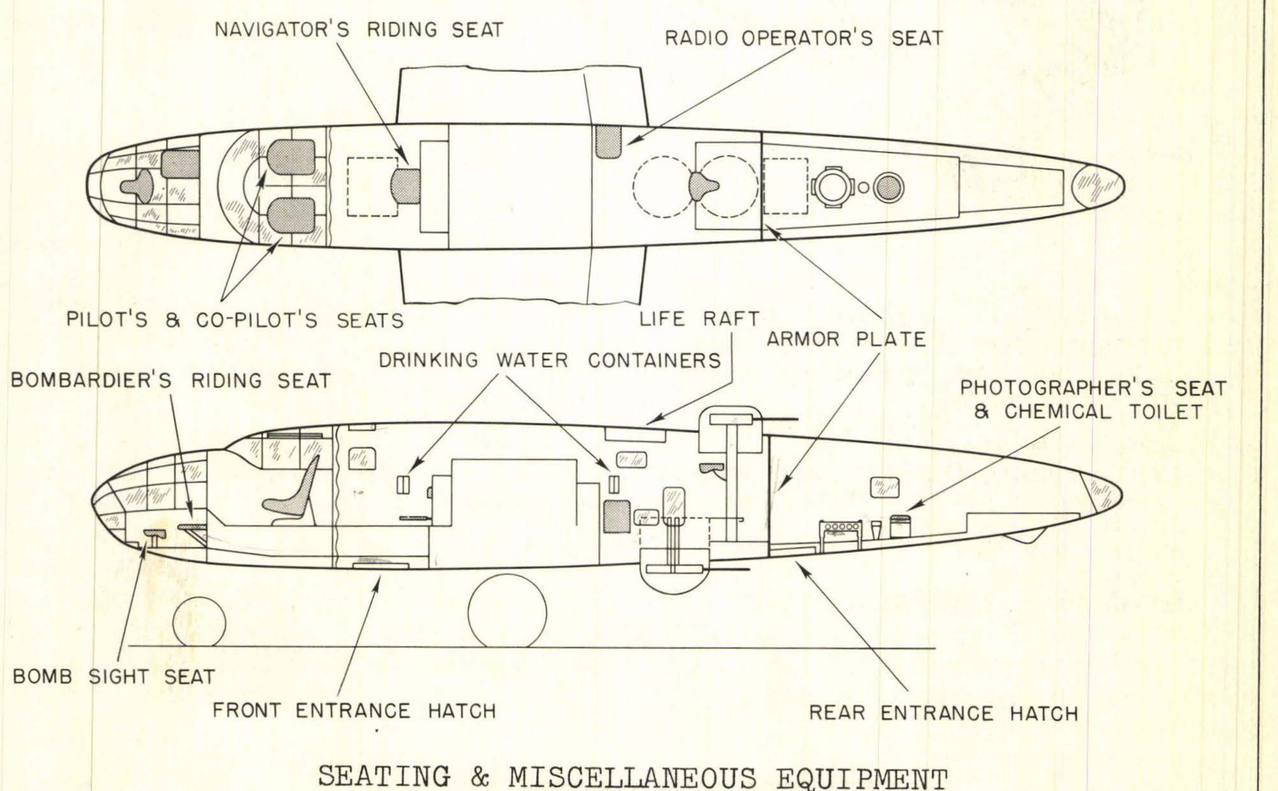


FIG. 7 SEATING & MISCELLANEOUS EQUIPMENT DIAGRAM

the gun turrets. The seat for the camera operator is an integral part of the toilet installation. Each seat, except bomb sight seat, camera, upper turret, and navigator's chart board stool, is provided with a safety belt. A stowage pocket is provided for stowing the navigator's riding seat safety belt.

CURTAINS

A curtain is provided between the pilot's and navigator's compartments. This curtain is provided with fixed sides and a rectangular door section that is secured at the corners by means of hooks. A canvas curtain is provided at the rear end of the crawl deck over the bomb bay and may be opened and closed by zippers. An adjustable sun shade is provided for the bombardier in B-25D airplanes. An adjustable sun shade and two sun visors are provided in the pilot's compartment.

TOILET INSTALLATION

The chemical toilet is an integral part of the camera operator's seat, located in the rear of the fuselage. The relief tube for the pilot, co-pilot, navigator and bombardier is located in the aft end of the navigator's compartment. The relief tube for the radio operator and gunners is located below the radio operator's table.

MISCELLANEOUS EQUIPMENT

A drinking water container and cup holder are provided at the left side of navigator's compartment and at the right side of radio operator's compartment.

A flight report form holder, a cloth airplane flight manual holder, a check list holder and two map cases are provided in the pilot's compartment. A transparent bomb data book container and a data stowage box are provided for the bombardier. A navigation form box, sextant stowage case and chart case are provided for the navigator. A data case for the radio operator is provided below the liaison receiver. Folding tables are provided for bombardier, navigator and radio operator. A maintenance check list is provided on the right rear side of the curtain between the pilot's and navigator's compartments. Ash trays are provided for the pilot, co-pilot, navigator and radio operator. A service ladder, provided with airplane, may be carried in the fuselage just aft of the rear entrance hatch.

ALARM BELLS

On B-25C airplanes, AC 41-12487 and subsequent, and in B-25D airplanes, AC 41-29848 and subsequent, the pilot is provided with a switch for control of alarm bells provided at the bombardier's station, radio operator's compartment and camera operator's compartment.

HAND FIRE EXTINGUISHERS

One carbon dioxide fire extinguisher is provided at the right

side of radio operator's compartment and one at the right side of the navigator's compartment. To remove a fuselage fire extinguisher from its stowage bracket, push up on retainer strap handle. To operate extinguisher, pull "RED" handle. Keep extinguisher erect and direct discharge close to base of fire. One carbon tetrachloride fire extinguisher is mounted on the inner side of the red door hinged on the lower outboard side of each engine nacelle.

SURFACE CONTROLS

Conventional dual wheel control columns, standard rudder pedals and trim tab wheels and dials operate the flight control surfaces and trim tabs. The interconnection is by means of cables, sectors, and push-pull rods. The control surfaces may be locked at their operating sectors by lock assemblies which are controllable from the pilot's station.

Due to the addition of gun turrets, armor plate and other equipment, the center of gravity has shifted rearward about four (4) per cent. This condition has been corrected by the installation of an elevator bungee.

PARACHUTES

Pilot's and co-pilot's seats will accommodate seat or back-type parachutes. Provisions are also made for stowing two attachable parachutes in the navigator's compartment, one in the radio operator's compartment and one near the rear entrance hatch. The pilot's seats are provided with both seat and back-type life preserver cushions.

EMERGENCY EXITS

There are two emergency exits which are accessible during flight or while the ship is on the ground; namely, the front entrance hatch, located in the navigator's floor, and the rear entrance hatch, located in the bottom of the fuselage midway between the bomb bay and fuselage tail.

PILOT'S EMERGENCY EXIT

The occupants of the bombardier's, pilot's and navigator's compartments shall make all emergency exits during flight and all normal entrances and exits while on the ground via the front entrance hatch. The hatch may be released in an emergency from within the airplane only, either before or after inner door over hatch is raised. The "RED" handle for releasing the hatch is located under the shelf above the forward left corner of the door and is equipped with a safety latch which must be disengaged before pulling handle. The control handle for normal operation from the inside is located under the shelf above the rear left corner of the door. The hatch and floor covering may be normally opened from inside or outside the airplane. Steps extend from the hatch when it is normally hinged downward. WARNING: Do not stand on hatch unless inner door is in place.

REAR EMERGENCY EXIT

The occupants of the entire rear section of the fuselage shall make all emergency exits during flight via the rear entrance hatch or lower gun turret scanning window. The rear entrance hatch operates identical to the pilot's entrance hatch and the normal and emergency controls are located on the left-hand side, just above the opening. The lower gun turret scanning window opens inboard and may be opened from either inside or outside the airplane.

ADDITIONAL EMERGENCY EXITS

The following openings should be used as means of escape on the ground only; however, under different circumstances and if necessary, all the following exits, except the camera station side windows, could be utilized as means of escape during flight. At this point it should be mentioned that if it is necessary to use the bombardier's escape hatch or pilot's side windows as means of escape during flight, it is important that the propellers be feathered and that the airplane is under control. The bombardier's escape hatch is located at the left side of the enclosure opposite the riding seat, and is releasable from either inside or outside the airplane, but opens inboard only. Pilot's escape hatch is located at the top of the enclosure between the pilot's and co-pilot's seat, and is releasable from either inside or outside the airplane, but opens outboard only. A latch is provided on the bombardier's and pilot's escape hatches to prevent opening hatches from outside the airplane when the airplane is locked. These latches should be checked prior to take-off to ascertain that latches are disengaged, so that hatches may be opened from outside in case of crash landing. Pilot's compartment side windows operate on tracks and are operable from inside airplane only; the control is located immediately below the window. Camera station side windows hinge at the top and may be opened from the inside only.

FLYING HOOD

A fabric instrument flying hood is provided for enclosing the pilot's half of the pilot's and co-pilot's compartment. The top of the hood is secured to the roof of the compartment by means of fasteners provided. A pocket built into the forward end of the hood enables it to be installed around the pilot's magnetic compass, which is mounted on the top center of the instrument panel shield. The two sides and front of the hood hang downward, unsecured, and may be raised with the hand whenever outside vision is required. When not in use, the hood is stowed in a cloth bag and secured at the left side of the anti-icer fluid supply reservoir, below navigator's riding seat table.

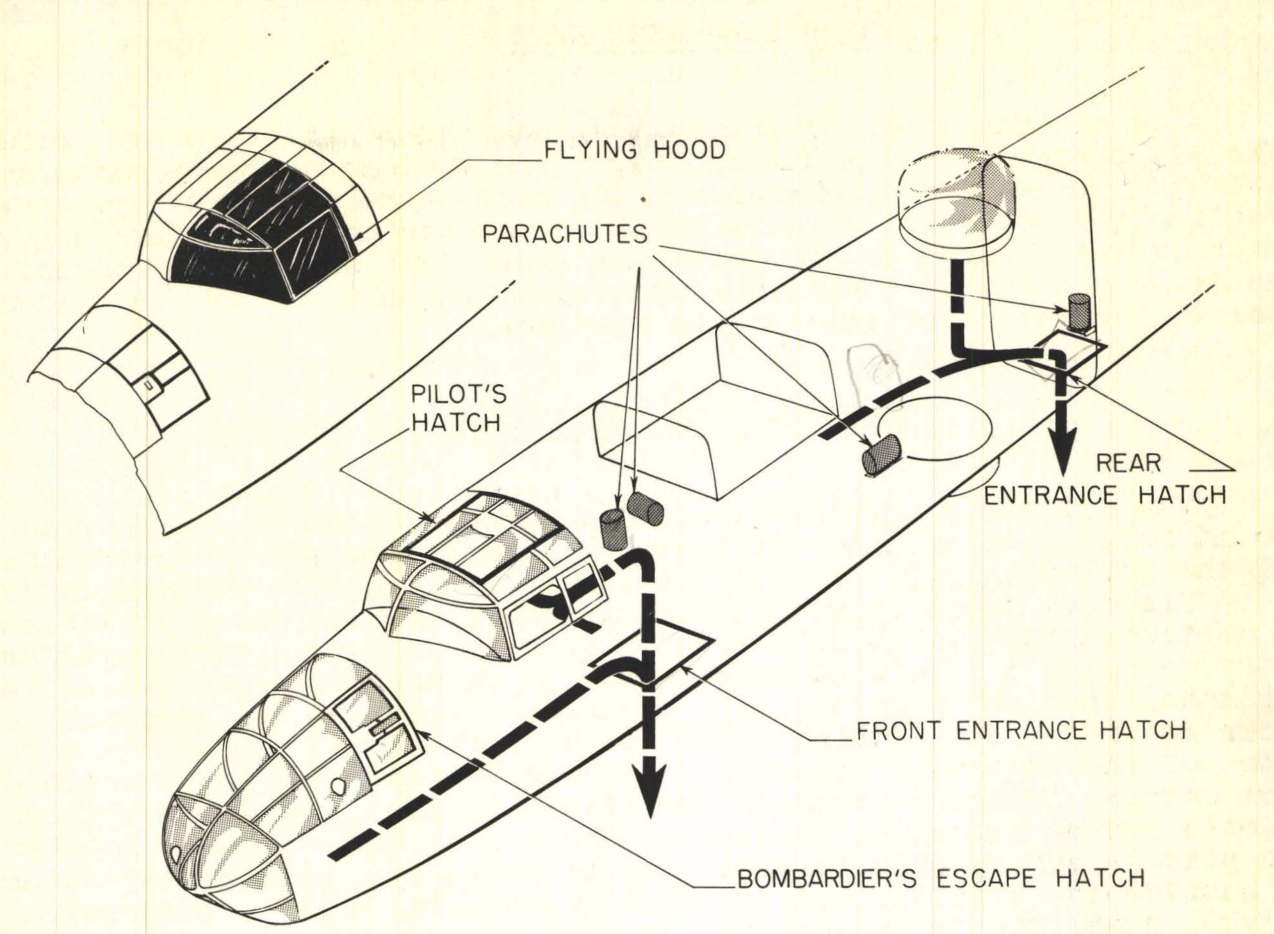


FIG. 8 EMERGENCY EXITS DIAGRAM

LIFE RAFT

A container for stowing a type A-2 life raft is built in the upper left side of the fuselage, above trailing edge of the wing. The life raft door is releasable from radio operator's compartment and from outside the airplane. The CO_2 valve for inflating the life raft, is interconnected with the door release handle in the radio compartment only; this is necessary in order to be able to remove door from outside without inflating life raft. A 25-foot mooring line is attached to the life raft and inner side of life raft container by means of swivel snaps. To install the type A-2 life raft, proceed as follows: First, remove life raft compartment door from outside of airplane; second, accomplish the pre-installation inspection specified in T. O. No. 03-55A-1B prior to proceeding with life raft installation; third, inspect the compartment for cleanliness and general condition. Check the draining provisions for general condition, deterioration and security. Lubricate the raft release mechanism in radio operator's compartment as required, using a soft grade of graphite grease. Spec. VV-G-671. Fourth, attach one end of mooring line to life line at bow of life raft; fifth, roll both ends of raft towards center to a size that will fit in the compartment and provide clearance to close compartment door; sixth, place raft in compartment

with small roll containing bottle at the outboard side of the compartment and coil mooring line on raft; seventh, attach loose end of mooring to fitting at rear of compartment; eighth, attach release cable to bottle release handle with screw and nut provided; ninth, replace compartment door and safety door handle with .016 inch lockwire in holes provided; tenth, check release handle inside radio compartment to see that it is properly engaged and safetied.

INSTRUMENTS

An instrument panel is provided and the pilot's instruments are divided into flight instruments and engine instruments. A type B-17 magnetic compass is mounted above and on the center of the pilot's instrument panel shield. A type B-16 magnetic compass is mounted at the forward left side of the bombardier's compartment. A type D-12 aperiodic compass is provided in the navigator's compartment. Provisions are made in the navigator's compartment for stowing a sextant. A type B-3 driftmeter is provided in the navigator's compartment. Provisions are made in the navigator's compartment for stowing a line-of-position computer. Provisions have been made for fluorescently lighting the pilot's instruments. The engine instruments are remote indicating Autosyn type. B-25C and B-25D airplanes are equipped with either A.F.C.E. or the Sperry type A-3 Automatic Pilot.

ELECTRICAL

Two 24-volt batteries are provided one inside each engine nacelle, immediately aft of the firewall. Either battery will operate the airplane's electrical system, including the starters, providing that either one of the battery disconnect switches is on.

The electrical system is of the 24-volt, single wire type. The ignition safety switch safeties the ignition system only. A disconnect switch is provided for each battery.

The bomb bay and each compartment of the airplane, with the exception of the tail look-out station, is illuminated with dome lights. Four cockpit lights are provided in the pilot's compartment, two cockpit lights are provided in the bombardier's compartment, and extension lights are provided for the co-pilot, bombardier and navigator.

RADIO

The airplane is provided with the following radio equipment, located as noted: Liaison set, located on the left-hand side of the radio operator's compartment, Command set, located on the right-hand side of the navigator's compartment, Radio-Compass, located on the left-hand side of the navigator's compartment, Marker Beacon Receiver located on the floor of the navigator's compartment on the left-hand side of the airplane. Interphone equipment is provided at all crew stations.

PHOTOGRAPHIC EQUIPMENT

A separate photography station is provided and is located at the aft end of the fuselage between the upper gun turret and tail look-out station. A vacuum valve and camera power junction box, the latter incorporating a signal light, intervalometer and camera power socket are conveniently located. Mounting provisions are provided for the installation of a type K-7C, K-3B, or a type T-3A camera. The camera is mounted on spring-loaded support tubes and may be readily raised to uncover the camera opening which is provided with a removable door. Side windows are provided for oblique photography.

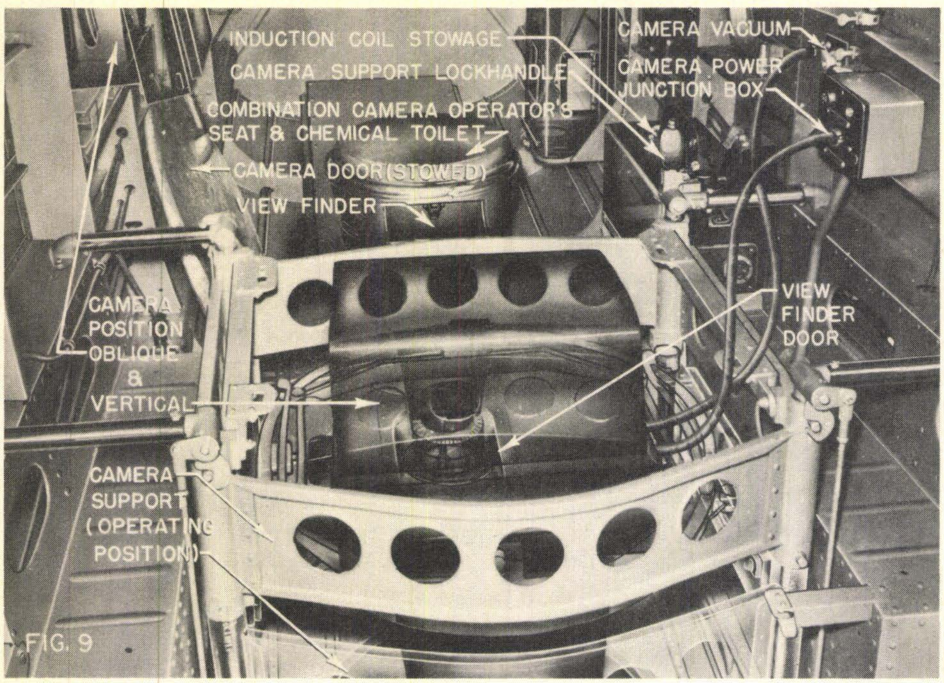


FIG. 9

ARMAMENT

A .30 caliber gun may be used in any one of three ball and socket mounts provided in the panels of bombardier's enclosure. A link and case ejection container is provided. A type G-4 gun camera may be flexibly mounted.

An upper Bendix Gun Turret, incorporating two .50 caliber machine guns, is provided in rear of fuselage. The upper turret guns are mounted side by side on Bell shock mounts, and are hydraulically charged and electrically fired. Oxygen and interphone equipment are provided for the turret. The turret may be operated from either a sitting or standing position. A flexible container is provided on each gun to catch the ejected links and cartridge cases. The turret cannot be retracted.

A lower Bendix gun turret, incorporating two .50 caliber machine guns, is provided in the rear of the fuselage just forward of the upper turret. The lower turret guns are mounted side by side on Bendix shock mounts, and are hydraulically charged and electrically fired. The gunner remains in a fixed kneeling position while oper-

ating the turret. Scanning windows are provided at each side of the fuselage adjacent to the gunner's operating position. The links and cartridge cases are ejected overboard through chutes positioned through the turret contour.

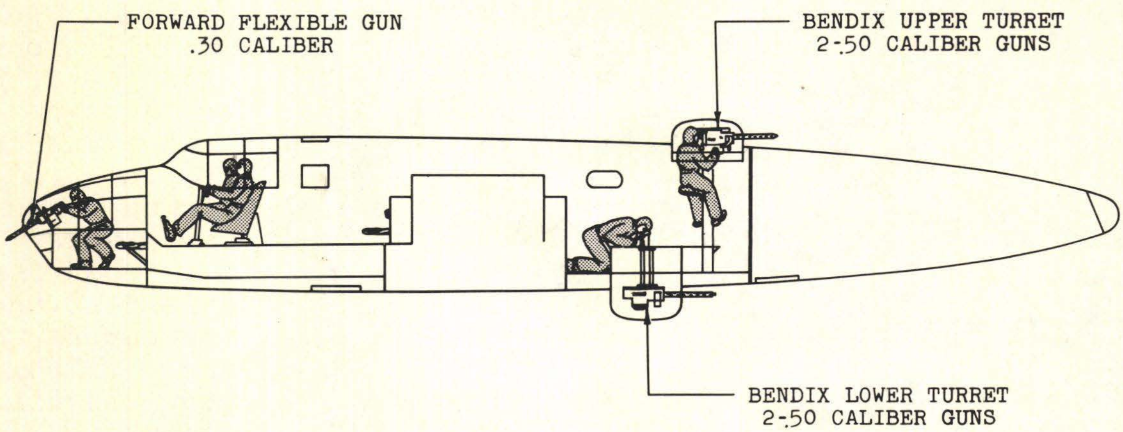


FIG. 10 ARMAMENT DIAGRAM

BOMB INSTALLATION

The bombardier's compartment is located in the nose of the fuselage. Provisions have been made for the installation of a bomb sight. A control is provided for locking the bomb racks; selective, salvo and emergency release of bombs, as well as opening and closing bomb doors. The bomb bay will carry demolition bombs, sizes 100 lbs. to 2000 lbs., and is located between the navigator's and radio operator's compartments. The bomb bay doors are normally automatically operated by hydraulic power through the door control and bomb release handle. In the event of complete hydraulic pressure failure, the bomb bay doors may be cranked open from the navigator's compartment. Access to the bomb bay may be had through a man hole located in the passageway above the bomb bay. Do not fly the airplane without bomb racks installed, as they form necessary structural members. Provisions for installation of wing racks are provided on 606th B-25C and subsequent.

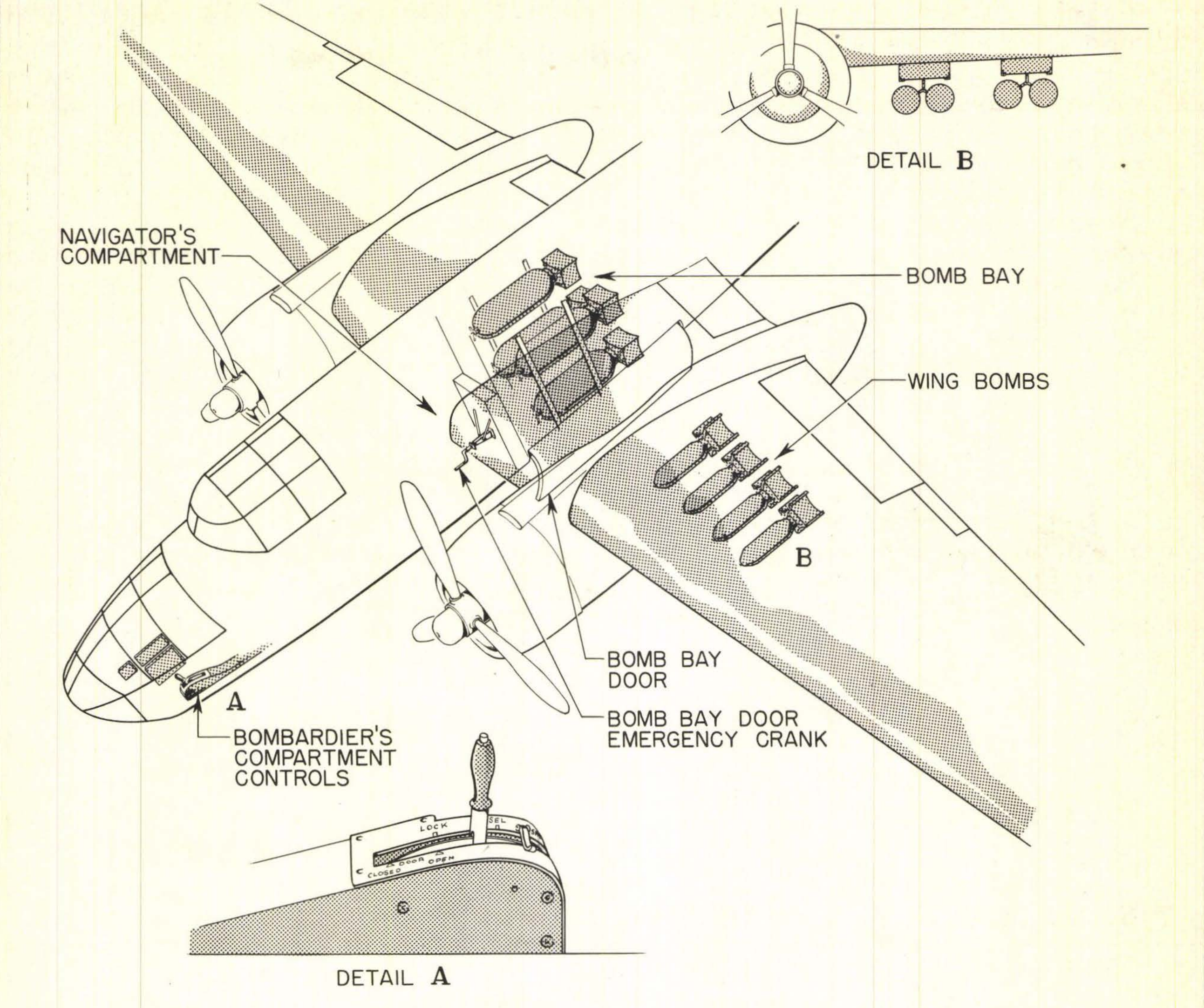


FIG. 11 BOMB INSTALLATION

HYDRAULIC SYSTEM

A single hydraulic system is employed for concurrent operation of main landing gear, nose gear and tail skid, and selective operation of wing flaps, engine cowl flaps, bomb bay doors and brakes. The primary source of pressure for the system is supplied by two engine driven pumps, one on each engine. Output of pumps is regulated by an automatic pressure unloading valve, which opens at a pressure of 1000 and closes at a pressure 800 lbs. /sq. in., and an automatic emergency relief valve,which opens at 1100-1200 lbs./sq.in. A secondary source of hydraulic pressure,for ground and emergency use only, is supplied by a hand pump. An emergency selector valve is employed to direct hand pump pressure through lines of the general system; through separate lines directly to brake system pressure accumulator; and to main landing gear down position latch system.

Two pressure accumulators are provided in navigator's compartment, one for the general supply system and one for the brake system. A pressure gauge is provided for each accumulator. The accumulator for the general system acts as a buffer and retains a small pressure reserve for use in the event both engine pumps fail. This pressure is not adequate for raising or lowering landing gear, but is sufficient for one direction operation of either wing flaps, engine cowl flaps, or bomb bay doors. Although pressure for brake system accumulator is obtained from the general system, it delivers pressure to the brake system only. The brake accumulator retains sufficient pressure for approximately 5 brake pedal applications (both wheels) in the event both engine pumps fail. A two-way restrictor valve incorporated in wing flap operating system prevents flaps from being operated abruptly particularly when raising flaps. A pressure gauge for the general system ("HYDRAULIC PRESSURE") and a pressure gauge for the brake system ("BRAKE PRESSURE") are located below the main instrument panel, forward of the co-pilot. The fluid reservoir, located in the navigator's compartment, is provided with a level gauge. A standpipe, provided in the reservoir, maintains sufficient reserve fluid for operation of the hand pump, even though the supply for the engine-driven pumps be lost. The upper and lower turret guns are hydraulically charged from the general supply system.

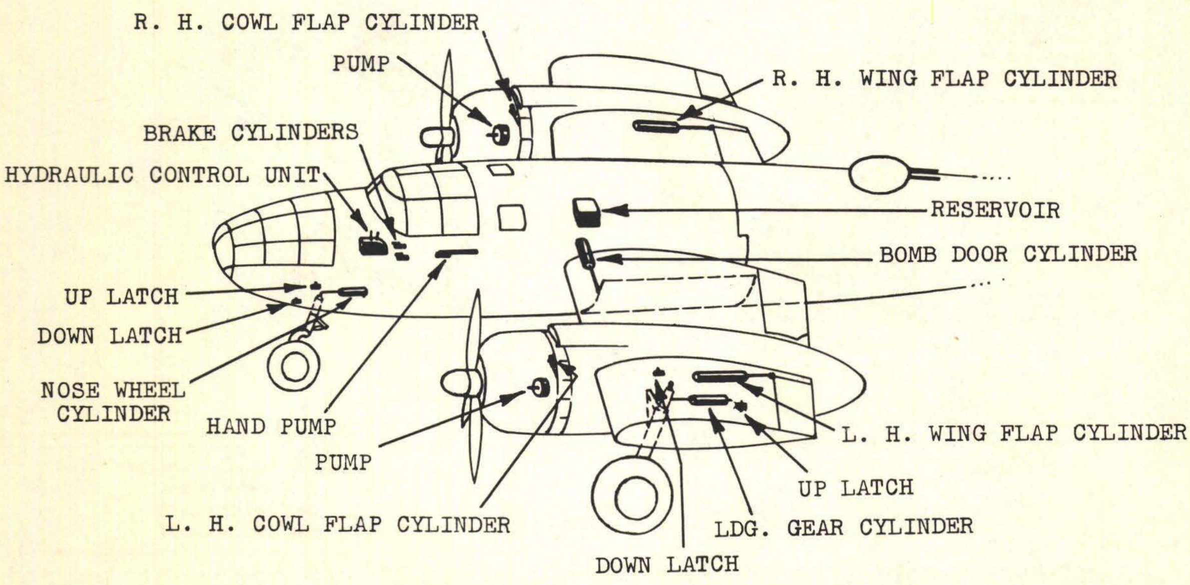


FIG. 12 HYDRAULICS DIAGRAM

OXYGEN SYSTEM

The oxygen equipment is of the low pressure type. Three type G-1 oxygen bottles are installed in each nacelle. Nine type A-9 oxygen regulators, one for each of seven stations and two for the bombardier are conveniently located. The six oxygen cylinders are filled in groups of three each, through a filler valve located on frame of each engine nacelle immediately forward of the landing gear struts. Each filler valve is accessible through the small landing gear strut door. The valves are provided with an integral automatic

flow check device, which automatically shuts off the oxygen flow when the filler unit adapter is removed.

Although the oxygen cylinders are filled in groups of three each, oxygen is consumed evenly from all six cylinders. To refill oxygen cylinders, remove protector cap from either filler valve and attach adapter from oxygen supply cylinder. Open the supply cylinder valve, and when any one of the nine oxygen regulators indicates 350 pounds per square inch pressure, close the supply cylinder valve, remove adapter and install protector cap on filler valve. Repeat the above procedure at opposite filler valve except, when an oxygen regulator gauge registers an increase of pressure above the 350 pounds per square inch already indicated, turn supply valve off; as this is an indication that all six oxygen cylinders have attained the required amount of oxygen. The relief valve in the bomb bay is set to function at 400 pounds per square inch, thereby preventing excessive overloading of the system. However, oxygen cylinders shall not be filled with more than 350 pounds per square inch pressure.

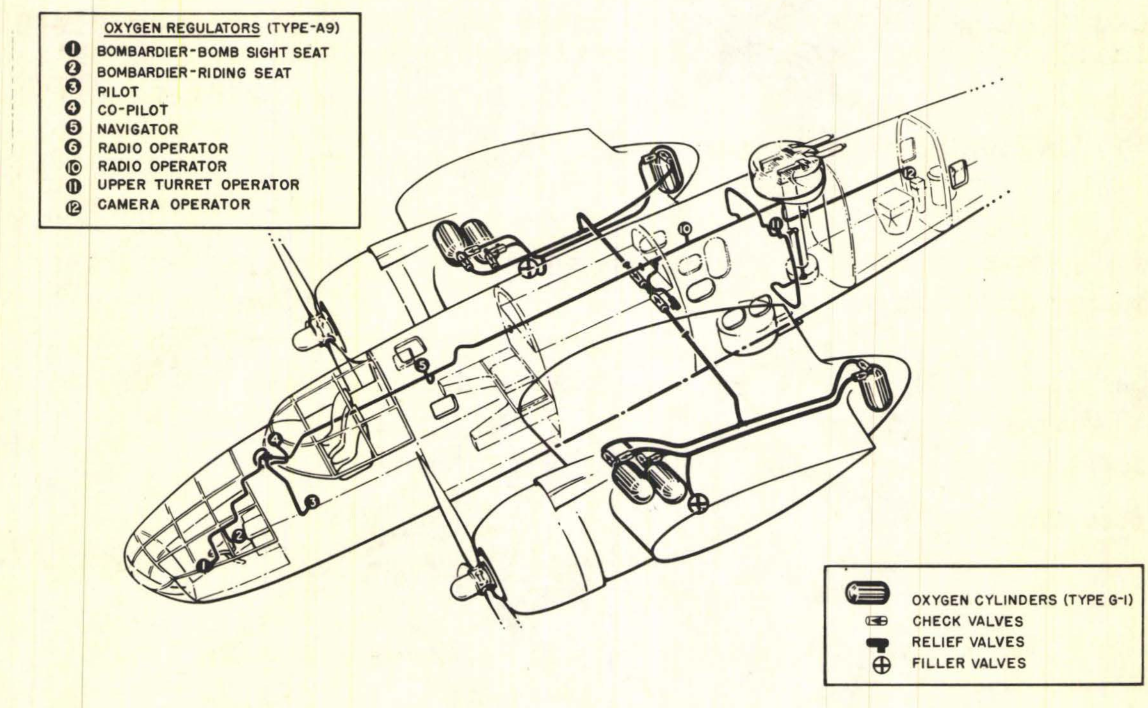


FIG. 13 OXYGEN SYSTEM

ASSEMBLY OF FLAPS & FLAP FAIRING DOORS

Before installing an inboard flap panel, install flap equalizer sectors and cables. Access to sectors is made in forward sides of radio operator's compartment, and aft end of bomb bay. Install cable guards above sector at a position approximately 1/16 inch(±1/64 inch) above cable and sector. Access to flap actuating mechanism is made by disengaging inboard main landing gear doors. Install flap fairing doors by holding doors in place and spinning piano type hinge pin into place from within nacelle. After hinge wire is in place, trim

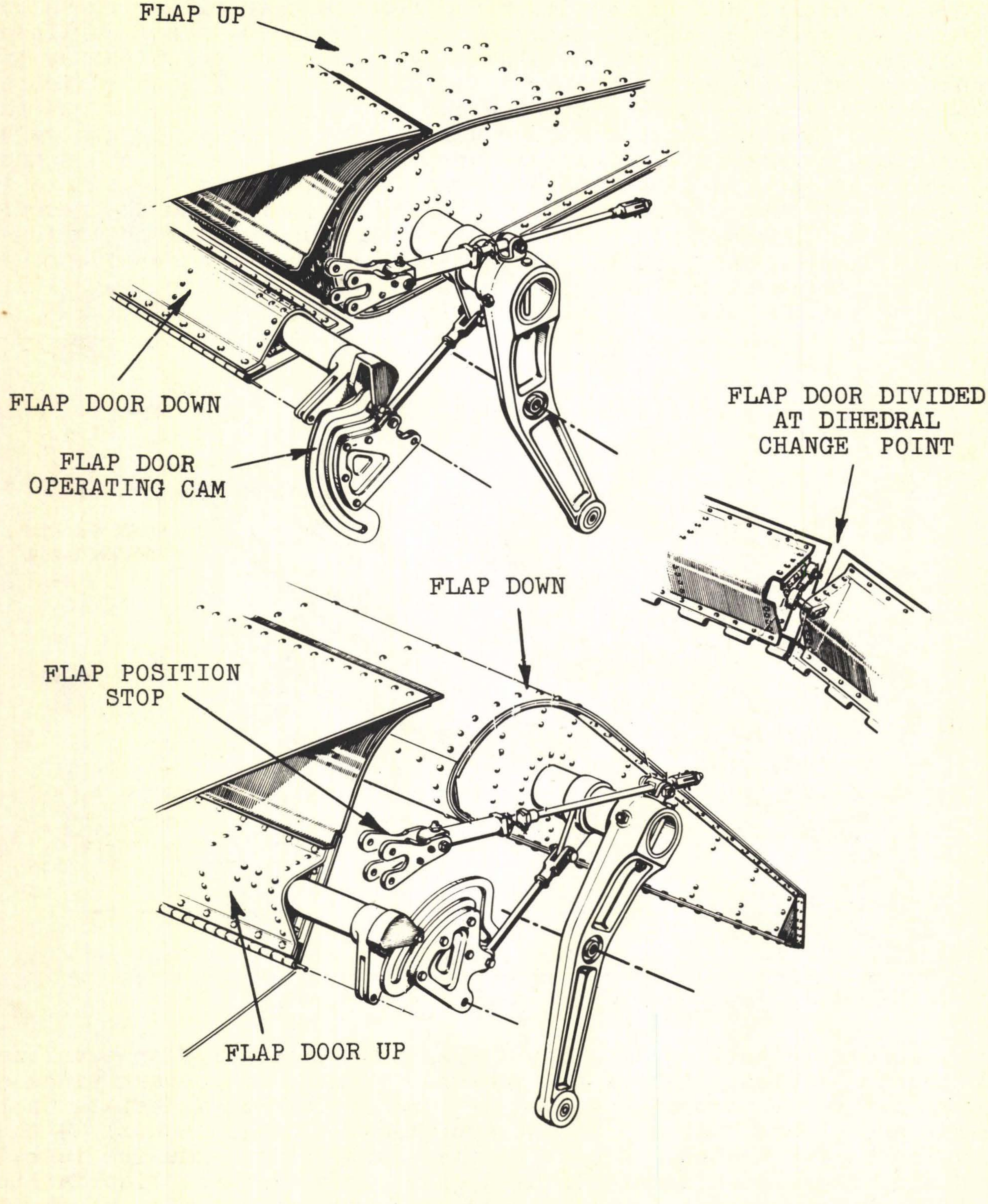


FIG. 14 FLAP FAIRING DOORS

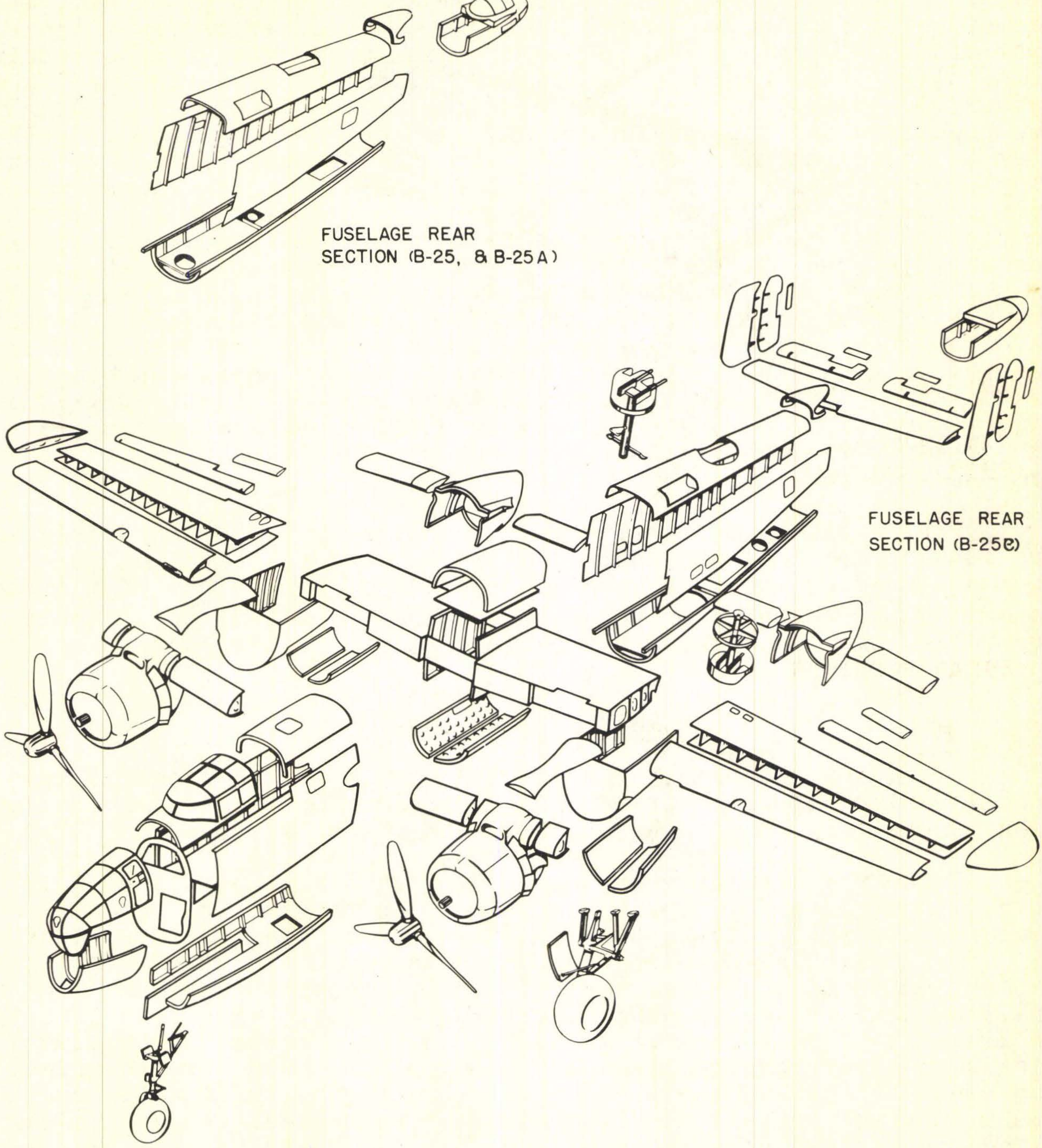


FIG. 15 EXPLODED VIEW

it allowing approximately 6 to 8 inches to extend from end of hinge for removal. The flap and flap fairing doors are to be adjusted as follows. It is to be noted, in the following adjustment instructions that the flap system will be so adjusted as to entirely eliminate all play. Operate flap controls by means of hand hydraulic pump to position flap actuating mechanism in relative up position of the flaps. With flap operating mechanism connected to jack shaft arm, adjust inboard flap actuating link to position flap in alignment with wing. Alignment should be made with projecting wing extension at nacelle, if extension is installed. After properly adjusting both inboard flaps, rig flap equalizer cables. With flap fairing door in down position and flap in up position, adjust fairing door operating link to position cam roller 1/16" from end of cam slot. Disconnect flap operating strut from jack shaft arm and move flap slowly to down position, ascertaining the nacelle door clears flap during operation (1/4" min.) and completely when flap is down. Also, make sure roller does not bind or reach end of cam slot when flaps are in up position, if readjustments are made in cam link, connect flap operating strut to jack shaft arm and adjust outboard flap and fairing door linkage in, same as above. Secure flap transmitter arm to interconnecting sector link located in left rear corner of bomb bay. In the event that parts or assemblies are replaced in the flap actuating mechanism, it may be necessary to utilize washers or spacers and rework parts, as required, to obtain proper operation of flap mechanism.

For instructions pertinent to removal, reverse the foregoing procedures for installation. It is to be noted that the trim tab cables should be taped or otherwise secured in the control and actuating drum grooves prior to disconnecting the cables. This procedure will prevent cables from unwinding from drum grooves, and thus facilitate reinstallation.

ASSEMBLY OF WING PANELS

The major sub-assemblies of the complete wing assembly may be installed individually or a complete outer panel assembly, except flap panels, may be attached to the center wing component.

Prior to installing the outer wing panels, the following items of equipment must be properly installed in the panels. Connect oil cooler shutter rod to shutter bellcrank near leading edge. Install oil line to leading edge of wing and hose connection to "Y" oil line at the center of the wing. Insert flotation compartment vent line at trailing edge of wing, secure flexible conduit to wing structure approximately 1 foot from wing bolting strip. Remove oil cooler and wing access covers and cover attaching plate from lower surface of the wing at bolting strip. Remove two plug bolts located on the front spar and install handling shackle assemblies. Attach hoisting sling with spreader bar to handling shackles, and hoist. Move wing to within a few inches of center section, connect rubber de-icer lines at wing leading edge to rigid lines of center section in their respective order. Engage wing to center section, install spar bolts then bolting strip bolts. Connect oil lines at leading edge and cen-

ter of wing, flotation compartment vent lines, oil cooler shutter control cable, and flexible electrical conduit. Connect airspeed lines at leading edge of right wing.

Prior to engaging wing tip to outer wing panel, secure a cord or wire to end of navigation light wire to facilitate connection of wire. Secure wing tip in place with screws. Start a few screws in top and bottom. Align upper surface of wing tip with that of outer panel by placing a straight edge along outer panel spar.

When installing aileron, hinge point centers may be aligned by varying thickness of washers between aileron hinge bracket and wing. Before installing aileron, ascertain that trim tab actuating mechanism is properly installed in wing, and aileron attaching eye bolts are attached to center and outboard hinge brackets. Install aileron and loosely secure in place with a spacer and nut in eye bolts, and a bolt and nut in inboard hinge. Move aileron outboard to obtain sufficient clearance between aileron and adjacent flap at all positions of flap and ailerson, and tighten attachments. Connect tab actuating link to tab mechanism then install aileron actuation link. Rigging and adjustment instructions are covered in the lecture on Surface Controls.

ASSEMBLY OF EMPENNAGE

The major sub-assemblies of the complete empennage may be installed individually, or the complete empennage assembly may be installed in one unit.

Prior to installation, all major attachment points and bonding attachment points shall be properly cleaned as required, to obtain proper bonding.

1. Prior to installing horizontal stabilizer to fuselage it is preferable to install all control cables, tab control assemblies, and electrical installations.

2. Coil and tape all cables, conduit and electrical wiring so they will not be in the way.

3. Place suitable stands at each side and rear of fuselage. Station at least two (2) persons at each end of stabilizer and manually raise it into place on the fuselage. (Weight is approximately 200 pounds).

4. Attach stabilizer to fuselage as shown on installation drawing.

Before installing an elevator section, ascertain that trim tab mechanism is properly installed in horizontal stabilizer, elevator attaching eyebolts are properly attached to hinge brackets, and bonding braid is installed under each outboard eyebolt attaching nut. Install bonding braids on outboard hinges under elevator attaching nuts.

The stabilizers are attached to the outboard ends of the horizontal stabilizer spars by means of bolts, nuts, and washers. It is advisable to install electrical equipment before installing vertical stabilizer on horizontal stabilizer.

Before installing a rudder, ascertain that trim tab mechanism is properly installed in vertical stabilizer; rudder attaching eyebolts are properly attached to hinge brackets, and bonding braid is installed under each upper and lower eyebolt attaching nut. Install bonding braid on upper and lower hinge under rudder attaching nuts.

It is to be noted in the following instructions that care shall be exercised not to permit elevator to swing free to the up position as damage will result to elevator at hinge cutouts. Also, care must be taken not to damage stringers on fuselage deck ahead of empennage.

1. Make sure bomb door and bomb-release signal lights, located above tail look-out station, are removed. Coil and tape flexible conduit so it will not be in the way.

2. Ascertain that all control cables and electrical wiring in the empennage are taped so as not to be in the way.

3. Check points of attachment, both on the horizontal stabilizer and the fuselage, for proper bonding.

4. Attach a suitable guide rope to the outboard side of each vertical stabilizer rear spar at the rudder sector, to facilitate guiding empennage into place.

5. Attach one end of four slings to a single hoist and the other ends (which should be suitably padded) around the two pulley brackets located on the horizontal stabilizer front spar and around the two elevator torque tube hinge brackets located on the stabilizer rear spar.

6. Hoist the empennage assembly and install it on the fuselage. It may be necessary to slightly raise the leading edge of the horizontal stabilizer manually while guiding the empennage into place. Make sure all control cables, conduit and wires are guided free as empennage is being installed. Also, guide the fairing strips attached to the fuselage at the elevator torque tube hinge brackets to the outboard side of the attaching angles on the horizontal stabilizer. Care must also be exercised so that the fairing strips do not damage elevator sections.

7. Attach stabilizer to fuselage as shown on installation drawing.

Removal - For instructions pertinent to removal, reverse the foregoing procedures for installation. It is to be noted that the trim tab cables should be taped or otherwise secured in control and actuating drum grooves prior to disconnecting the cables. This procedure will prevent cables from unwinding from drum grooves and thus facilitate reinstallation.

REMOVING FUSELAGE SECTIONS

Procedure for disassembly of fuselage sections is covered thoroughly in the Hand Book of Operation and Service Instructions for these airplanes. It should be referred to for detail procedure to follow in the assembly of various fuselage sections. A few precautionary notes are probably in order at this time.

1. Control cables should be properly identified before they are disconnected in order to facilitate reassembly.

2. Drain Fuel System.

3. Release the hydraulic pressure from the accumulator, and drain hydraulic system.

4. When disconnecting fuel, hydraulic, etc. lines, plug all ends to prevent foreign matter from entering the lines.

5. Remove the inboard flaps before disassembling rear fuselage section.

6. When reassembling the center and rear fuselage sections, take precautionary measures to prevent the extreme trailing edge of center wing from puncturing rear section of fuselage.

7. Precaution must be exercised when connecting front and center sections of fuselage to ascertain that leading edge of wing does not damage front section of fuselage.

TOWING

A towing bar, Drawing No. 62-55003, (one provided for every six airplanes) shall be attached to the nose wheel strut for towing the airplane forward over hard level ground. When it is necessary to tow the airplane backward, or when the airplane is to be towed forward or backward over uneven or soft ground, ropes shall be attached to the towing rings provided on the main landing gear struts. In all cases, steering while towing will be accomplished by means of the towing bar.

To install towing bar, insert axle of bar into upper end of nose wheel support arm, and lock by turning axle. To disengage pin from strut and permit steering of the wheel, force wedge, Drawing No. 62-55014 (chained to towing bar), into the nose wheel tow pin located at lower torque arm strut attachment fitting. CAUTION: After towing remove wedge and engage nose wheel tow pin by centering nose wheel with towing bar. The nose wheel support arm must be on right side of airplane in order to engage tow pin. The nose wheel cannot be turned when strut is completely retracted, unless tow pin is disengaged.

JACKING

One jack fitting bolt, 55-55008, is provided for installation in the fuselage, just forward of the nose wheel. Two jack fitting bolts, 62-55024, are provided for installation in the wing center section, one on either side of each nacelle. Plug screws, 62-55033, are provided for installation in the wing jack fitting sockets when jack fittings are not installed. Always engage the parking brakes and block the wheels when jacking a portion of the airplane. Always remove the center section jack bolts and install plug screws when jacking is completed.

Non-removable jack-points are provided on the three landing gear struts. These jack points shall only be used in an emergency.

DO NOT jack airplane from a single wing jack point. Whenever jacking is to be accomplished and it is possible to do so, it is recommended that the complete airplane be jacked off the ground, utilizing the center section and fuselage jack points. As soon as airplane is elevated evenly from all three jack points, place a padded support conforming to the shape of the fuselage under the bulkhead located immediately forward of the tail skid. If this type of support is not available, place a platform under the tail skid. When lowering jacks, make certain support is removed from under tail of fuselage.

The outboard center section jack points shall be used in lieu of the inboard center section jack points except when center section end rib doors are removed, or when the landing gear wheels are to be removed and the base of the jack stand available is too large to permit pulling of the wheels. It is to be noted that the outboard jack points may be used when the outer wing panels are removed, providing that the center section end rib doors are installed.

Prior to jacking nose of airplane, remove supports, etc., from under tail of fuselage. Engage the parking brakes and place wheel chocks in front and back of main landing gear wheels.. Jack nose of airplane until it is elevated sufficiently, then place a support under tail of airplane.

HOISTING

The complete airplane may be hoisted, either with or without engines and outer wing panels installed, providing that fuel and oil tanks are drained and the proper hoisting equipment used. To install hoisting shackles, remove bolts 62-55034, from each inboard engine mount attachment fitting on wing center section front spar and install airplane hoisting sling shackle assemblies, 62-55035. Bolt handling shackle assembly, 62-55032, to each horizontal stabilizer rear spar attaching fitting and safety nuts with cotter pins. The airplane may then be hoisted after installation of proper hoisting slings and spreader bar. Spreader bar is to be not less than Std. 6" x 6".

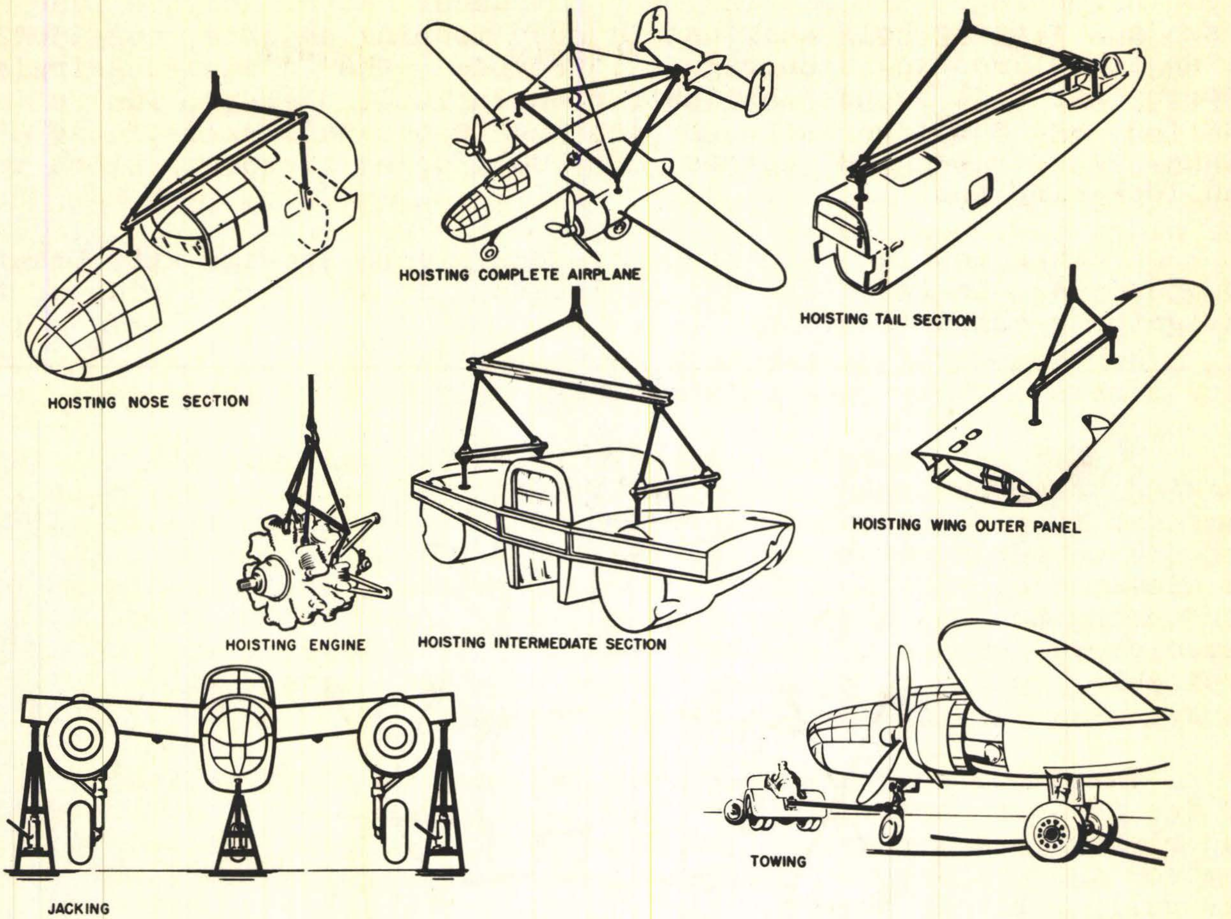


FIG. 16 TOWING - JACKING - HOISTING

LEVELING

Longitudinal and lateral leveling lugs are provided on the lower fuselage longerons in the aft end of the bomb bay. The longitudinal brackets are bolted to the right longeron and are approximately 30 inches apart.The forward longitudinal bracket and a bracket on the lower left fuselage longeron are used as the lateral leveling points. These lugs are parallel to the longitudinal and lateral reference datum lines of the fuselage and wing.

MOORING

Prior to mooring airplane, block main landing gear wheels, engage parking brakes, lock surface controls, and install hydraulic control lock. Also ascertain that nose wheel tow pin and pilot's nose wheel control plunger are engaged. Remove the four wing mooring socket plug screws, 62-55033, from lower surface of each outer wing panel forward of aileronand adjacent to outboard side of engine nacelle,and install the four wing mooring shackle fittings,62-55028.

A service ladder, 62-73026, is provided with each airplane to facilitate installation of wing mooring fittings. The ladder may be carried in fuselage, aft of the rear entrance hatch. Remove fuselage nose jack fitting bolt and install nose mooring shackle, 62-55042. If no fixed mooring anchorage is provided, the standard airplane mooring kit will be used as instructed in T. O. 01-1-50. The tail of the fuselage shall be moored by lashing to the tail skid of the airplane. Install engine covers, 62-72003, cover airspeed pitot tube, and lock airplane.

A cloth mooring and handling equipment stowage kit, Drawing No. 62-55041, is provided and is located at the right side of the navigator's compartment.

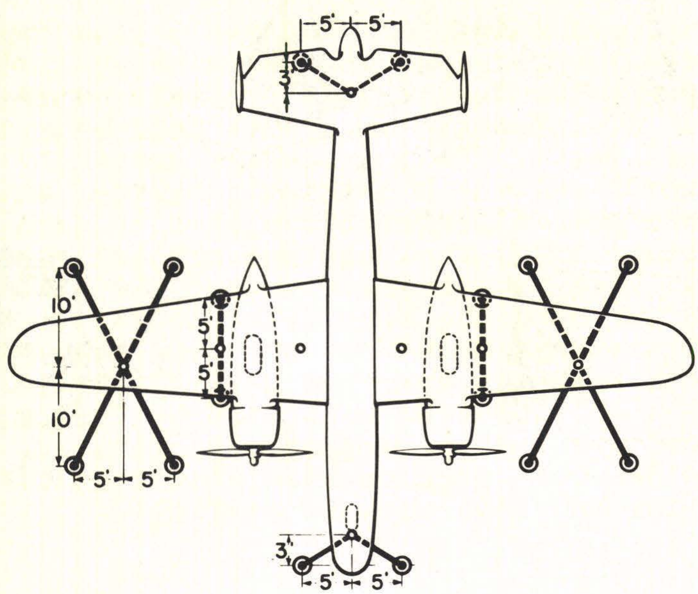


FIG. 17 MOORING

ADDENDUM I

Items peculiar to B-25 Airplanes only.

1. **FUEL TANKS**

The fuel compartment on B-25 Airplanes only are an integral part of the wing center section structure and consists of four tanks, a front and rear tank in each wing.

2. **HYDRAULIC FUEL SYSTEM**

On B-25 Airplanes only, each engine is provided with an independent fuel system, supplied by two tanks in each wing, and a droppable bomb bay tank. The fuel system consists essentially of a hydraulically driven fuel pump,an emergency hand pump,a fuel strainer, an electric primer valve, and a manually operated fuel selector valve and cross feed valve. A hydraulic system entirely separate from the airplane's general hydraulic system is used to operate the fuel pumps. The independent fuel systems are interconnected by means of cross suction lines which interconnect the suction side of each fuel pump through the opposite fuel selector valve, thereby making either or both engines operable from any fuel compartment. A cross pressure line, with manually operated shut-off valve, is incorporated to permit operation of either or both engines from either or both fuel pumps. In the event of an engine pump failure, either pump has adequate capacity for both engines except at take-off power. Each carburetor incorporates and idle cut-off device.

ADDENDUM II

Items peculiar to B-25A Airplanes only.

1. **FUSELAGE**

On B-25A Airplanes only, an armor plate bulkhead and door is installed just aft of the rear entrance hatch instead of forward of this hatch as on the later airplanes.

ADDENDUM III

Items peculiar to B-25 and B-25A Airplanes only.

1. GENERAL

The normal combat crew of five consists of a pilot, co-pilot, bombardier, radio operator, and waist gunner; however, seats are provided for a crew of nine. Three folding riding seats are installed in the waist gunner's compartment to carry the additional crew members.

2. FUSELAGE

On B-25 and B-25A Airplanes only, the radio-camera operator's compartment, top, side and bottom waist gunner's stations and tail gunner's compartment are located from the bomb bay to the tail of the fuselage; a canvas curtain is installed between the top and side gun stations.

3. REAR EMERGENCY EXIT

On the B-25 and B-25A Airplanes, the occupants of the entire rear section of the fuselage, except tail gunner's compartment (refer to following paragraph) shall make all emergency exits during flight via the rear entrance hatch (lower waist gun mount door), or side waist gun window. To open rear lower hatch without releasing gun mount, pull straight up on the handle and pull hatch open. Do not turn handle, for if this is done, the gun mount and its door will be released and prevent exit through the hatch opening. When closing hatch, lift up on handle and close door, being careful not to turn handle, as the gun mount door will open. Normal ingress and egress to the entire rear section of the fuselage is made through the rear entrance hatch by means of a ladder which is stowed at left side of fuselage just forward of the hatch. The hatch opens inboard from inside or outside of the airplane; when outside of airplane to open hatch, unlock and push in on rear of flush type handle and pull down on forward end of handle. With the handle down, push hatch upward against stowage catch on side of fuselage.

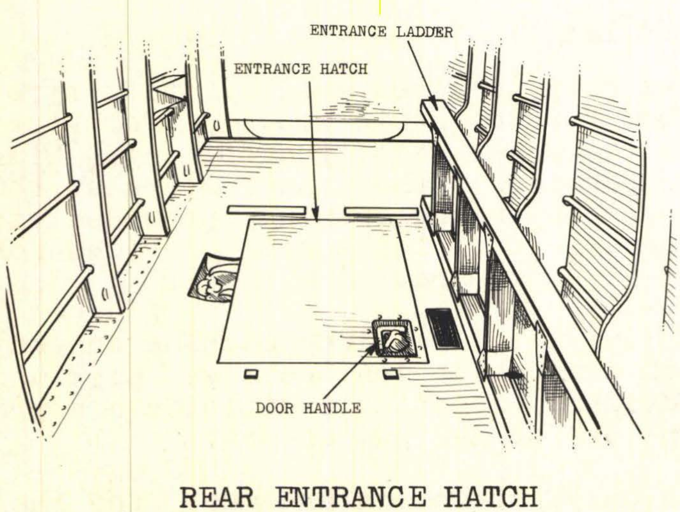


FIG. 18 REAR ENTRANCE HATCH B-25 and B-25A

4. TAIL GUNNER'S EMERGENCY EXIT

The tail gunner, on B-25 and B-25A Airplanes only, shall make all emergency exits through the enclosure escape hatch located directly above his seat. This hatch is releasable from either inside or outside of airplane, (as described in gun installation lecture.)

5. WAIST GUNNER'S EMERGENCY EXIT

On B-25 and B-25A Airplanes only, the side waist gun windows may be used to effect an emergency exit during flight, or while on ground. The windows slide upward on tracks and are only operable from inside the airplane.

6. TOILET INSTALLATION

On the B-25 and B-25A Airplanes only, a chemical toilet is installed in the floor of the fuselage just forward of the upper waist gun mount. The tail gunner's relief tube is located at the side of his seat.

7. CURTAINS

On the B-25 and B-25A airplanes only a curtain is provided between the upper and side waist gunner's station. This curtain is provided with fixed sides and a rectangular door section that is secured at the corners by means of hooks.

8. ELECTRICAL

On the B-25 and B-25A airplanes only the electrical system is of the 12-volt, single wire type. Each 12-volt battery is charged by its respective 15-volt, 50 ampere engine driven generator. The ignition safety switch safeties the ignition system as well as the entire electrical system.

9. ARMAMENT

On B-25 and B-25A airplanes only, a fixed anti-aircraft type gunpost centrally mounted in floor of fuselage is provided for flexibly mounting a .30 caliber gun at the upper waist gun opening. Link and case ejection containers are provided. The gunner operates the gun from a standing position through an oblong opening, provided with sliding transparent doors. Mounting facilities are provided for flexibly mounting a type G-4 or H-2 gun camera.

On B-25 and B-25A airplanes only,a .30 caliber machine gun may be mounted on a fixed post at both side waist gun openings. Link and case ejection containers are provided. Mounting facilities are provided for flexibly mounting a type G-4 or H-2 gun camera.

On B-25 and B-25A airplanes only,provisions are made for the installation of a .50 caliber machine gun,equipped with a Bell shock mount,in the tail gun position.Link and case ejection containers are

not provided. The tail gunner fires the gun from a sitting position, through mechanically operated clam shell doors. Suitable armor plate is provided for protection of the tail gunner.

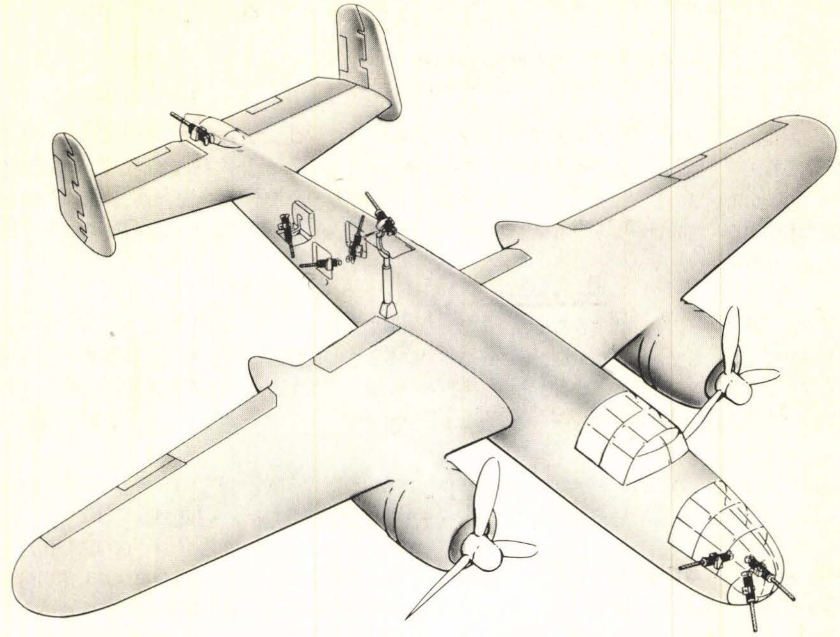


FIG. 19 ARMAMENT B-25 and B-25A

10. PHOTOGRAPHY EQUIPMENT

Mounting provisions are provided for the installation of a type K-7C, a type K-3B, or a type T-3A camera. The manual camera door control (used on B-25 and B-25A only), vacuum valve, and camera power junction box, the latter incorporating a signal light and intervalometer and camera power sockets, are conveniently located. On B-25 and B-25A airplanes the camera mounting provisions are located in the radio operator's compartment, immediately aft of the bomb bay. The provisions are covered when not in use by a floor which hinges on the bomb bay wall. The view-finder opening, located immediately aft of the camera mount, is provided with a door which may be opened with a control provided. A shelf for the placement of either a shutter induction coil or an extra film magazine, is provided below the liaison receiver. A rest is provided for installation on either side waist gun window for taking oblique photographs. The rest is secured to the window sill and to its stowage brackets located immediately forward of left window by means of dzus fasteners. On B-25B airplanes a separate photography station is provided and is located in the aft end of the fuselage between upper gun turret and tail lookout station. The camera is mounted on spring loaded support tubes and may be readily raised to uncover the camera opening which is provided with a removable door.

ADDENDUM IV

Items peculiar to B-25B airplanes only.

1. ELECTRICAL

Two 12-volt batteries are provided, one inside each engine nacelle, immediately aft of the firewall. Either battery will operate the airplane's electrical system, including the starters, providing that the ignition safety switch and either one of the battery disconnect switches are on.

The electrical system is of the 12 and 24 - volt single wire type. The 24-volt system operates the gun turret motors only. The ignition safety switch safeties the ignition system only. A disconnect switch is provided for each battery.

The bomb bay and each compartment of the airplane, with the exception of the tail look-out station, is illuminated with dome lights. Four cockpit lights are provided in the pilot's compartment, two cockpit lights are provided in the bombardier's compartment and extension lights are provided for the co-pilot, bombardier, and navigator.

2. FUEL TANKS

The fuel compartment on the B-25A and B-25B airplanes only are of the self-sealing gas cell type and differ from the B-25C tanks in that each tank is made up of four gas cells, whereas, each B-25C gas cell is a complete tank in itself.

3. SIMPLIFIED FUEL SYSTEM

On B-25A and B-25B airplanes, each engine is provided with an independent fuel system. Fuel and transfer lines are of the self-sealing "BULLETPROOF" type. Fuel is supplied from a front and rear fuel compartment in each wing and a droppable bomb bay tank, the latter being usable only for transferring fuel into the wing fuel compartments. The two wing fuel compartments are interconnected by a check valve to prevent fuel from returning to the rear compartment. An electrically operated booster pump is provided forward of the check valve and is mounted directly to the front tank. This pump supplies fuel through a strainer to an engine-driven pump mounted directly on the engine. A fuel transfer system, with manually operated selector valves and an electrically operated pump, is provided to transfer the fuel from either right or left fuel compartments to the opposite front fuel compartment, or from the bomb bay tank to either right or left fuel compartments. An electrically operated priming system is provided. Each carburetor is of the fuel injection type and incorporates an idle cut-off device.

ADDENDUM V

Items peculiar to B-25, B-25A and B-25B airplanes only.

1. OIL SYSTEM

On these airplanes the oil cooler shutters are controlled throughout by rods instead of cables as on the B-25C and subsequent models.

2. POWER PLANT CONTROLS

The power plant controls on all these airplanes are the conventional push-pull rod type, and are operable from the pilot's compartment only.

3. HEATING AND VENTILATING

On these airplanes a steam heating and ventilating system is provided. The system consists essentially of a boiler in the left engine exhaust tail pipe, the radiator in the left wing center section nose, a reservoir in the navigator's compartment and the necessary ducts and valves.The pilot is provided with a control for regulating the cold air entering the radiator.Warm air from the radiator and cold air from an intake duct are regulated in a mixing chamber controlled by the navigator.The air,after passing through the mixing chamber is conducted through ducts to valve equipped out-lets in each normally occupied compartment. In addition to the above, controllable cold air scoops are provided for the pilot, co-pilot, and bombardier.

4. PYROTECHNICS

Provisions are made for the installation of a type M-2 Pyrotechnic pistol and 26 signal flares on the sides of the fuselage at the top of the waist gunner's station. Six type M-9 parachute flares and the pistol may be installed on the right side of the fuselage. Ten type M-10 white star and ten type M-11 red star parachute signals may be installed on the left side of the fuselage. The flares on the left side of the fuselage are accessible by lowering the back rests of the riding seats.

5. RADIO

The Liaison set and Command set are on the left and right sides of the radio operator's compartment, respectively. The Radio Compass and Marker Beacon equipment are located in the navigator's compartment. The pilot and co-pilot are provided with a common amplifier controlled by push-button switches located on pilot's and co-pilot's control wheels.

6. BRAKES

On the B-25, B-25A and B-25B airplanes only, a debooster which lowers brake system pressure to approximately 125 lbs. / sq. in.is mounted on each landing gear strut. This is necessary as low pressure disc brakes are used on these airplanes.

7. ENGINES

On the B-25, B-25A and B-25B airplanes only, two double row, Wright Cyclone R-2600-9 engines are used.

Right Nacelle

Oxygen Tanks (6)
" Filler valve (2)
" Relief valve (Bomb Bay) (1)
" Check valves (14)

Mooring points
Jacking points
Towing points & Hoisting points
Fire Extinguisher

Rear & Front of Ship

Escape & Exit Hatches (5)
Furnishings
Oxygen Regulators (8)
Life Raft

Furnishings

2 Fire Extinguishers (CO_2)
2 Water containers
4 Parachutes
1 Blind Flying Hood

GENERAL
POWER PLANT

NORTH AMERICAN AVIATION Inc.

Power Plant LECTURE

B-25 SERIES AIRPLANES

PREPARED BY Edward B. Felmer

NOTE

THE INFORMATION CONTAINED IN THIS LECTURE WAS CORRECT AS OF JANUARY 1, 1942. REFER TO HANDBOOK OF OPERATION AND SERVICE INSTRUCTIONS FOR THE LATEST INFORMATION.

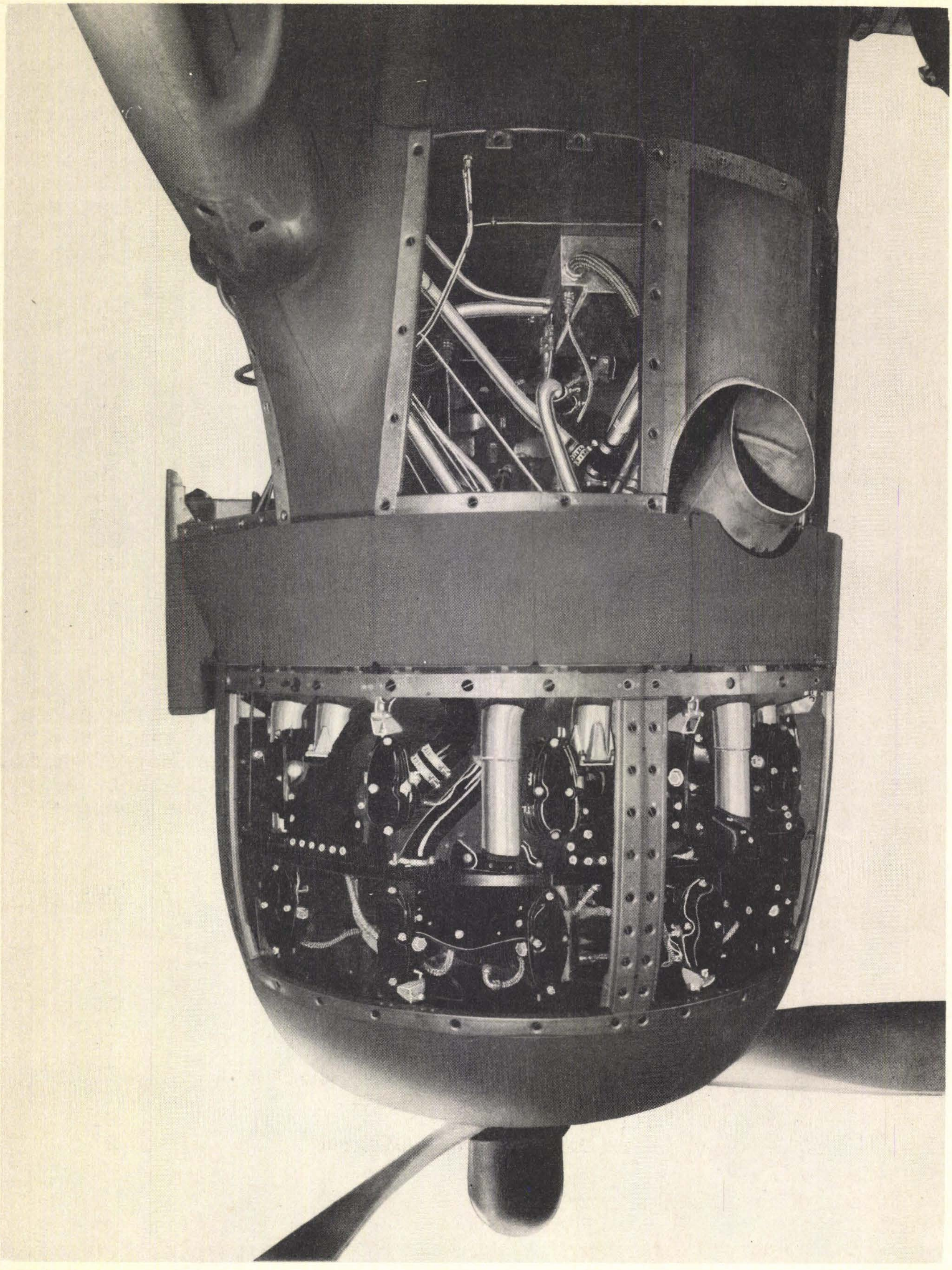
THIS DOCUMENT CONTAINS INFORMATION AFFECTING THE NATIONAL DEFENSE OF THE UNITED STATES WITHIN THE MEANING OF THE ESPIONAGE ACT, 50 U.S.C., 31 AND 32. ITS TRANSMISSION OR THE REVELATION OF ITS CONTENTS IN ANY MANNER TO AN UNAUTHORIZED PERSON IS PROHIBITED BY LAW.

N A A

INGLEWOOD, CALIFORNIA

INDEX

ILLUSTRATIONS



INTRODUCTION

In this series of lectures on the B-25C power plant section, we shall attempt to give you a good working knowledge of that part of the airplane, so as to minimize the inefficiency resulting from trying to operate an unfamiliar airplane. No comments will be made concerning very routine information already known to you. Likewise, information available to you in Technical Orders, Bulletins, etc., will be only lightly touched upon. This is necessary to allow as much time as possible to be spent on items which are unusual or regarding which information may be hard to obtain.

This section will be covered in seven lectures covering every phase of the installation, as follows:

1. General Power Plant.
2. Fuel System.
3. De-icer System.
4. Heating and Ventilating System.
5. Engine Servicing.
6. Propeller Servicing.
7. Engine Performance.

Each lecture will be followed by a question and answer period, then a tour of the shop to view and discuss items which were covered in the lecture. It is suggested that the questions asked during these periods be confined to the subject matter of the lecture just given, and that any other be noted and asked when the lecture on that subject is presented.

First, we shall cover the general power plant installation; discussing in general terms the installation as a whole, and going into detail on the following installations:

1. Cowling and Air Induction.
2. Engine Mounting.
3. Exhaust Collector.
4. Engine Controls.
5. Oil System.
6. Fire Extinguisher.

Each subject, as applicable, will be approached to give you a picture of its design, operation, service and installation require-

ments, and a discussion on trouble to be expected and how to correct same.

ENGINE

Our power is obtained from two Wright R-2600-13, fourteen (14) cylinder, twin-row, air cooled engines. The engines are equipped with two speed superchargers, have a compression ratio of 6.9:1, and drive the propellers through a 16:9 reduction gear. It is required that 100 Octane fuel, Specification AN-9531, and grade 1120 lubricating oil, Specification AN-9532, be used.

PROPELLERS

Fitted to the engines are twelve (12) foot seven (7) inch diameter three bladed, constant speed, Hamilton Standard, Hydromatic Propellers. Hamilton Standard, Model 4L11, constant speed governors control the blade settings. The propellers may be completely feathered. Operation of the feathering and pitch control will be described later on.

CARBURETOR

The carburetor is a Holley type, which incorporates an automatic mixture control and an electric primer.

SPARK PLUGS

B-G type spark plugs are used, although several other types have been approved and may be supplied for replacement in these engines. If roughness is experienced after a new set other than B-G is installed, we recommend that B-G be tried before investigating the rest of the ignition system. Access to the spark plugs is possible by removing the cowling panels over the cylinder heads and unbuttoning the engine cylinder head baffle which covers the rear row of plugs only.

MISCELLANEOUS ENGINE ACCESSORIES

The fuel pump is the type G-9 and is installed directly on the accessory section of the engine.

One, type P-1, two hundred (200) ampere generator is used on each engine. The electrical system on this airplane is a complete twenty-four (24) volt system.

A type G-2 starter is installed on both engines in such a manner that the hand cranking extension shaft comes out on the inboard side of each nacelle. One hand crank is supplied with each airplane and is stowed in the left nacelle just aft of the firewall. All starting and priming controls are located in the cockpit; it is only possible to hand energize the starter from the ground. Since

the starter may be operated electrically in several different manners, more detailed discussion on this subject will be reserved for the electrical installation lecture.

A type B-12 Vacuum Pump, a Pesco, type 203AD, Hydraulic Pump and Tachometer Generator complete the list of accessories mounted on the engine.

SERVICING OF ENGINE ACCESSORIES

Installation of the various accessories just discussed, and of other items attached to the engine, has presented several problems worth noting.

A number of one-fourth (1/4) inch lines are connected to the carburetor with one-eighth (1/8) inch pipe fittings. The installation of these will require care to avoid breakage due to overtightening. The fittings will usually break inside the carburetor, creating a difficult extraction problem. This has occurred several times in our shop.

Assembly of the starter will require care when reinstalling the four bolts used to hold on the housing for the hand cranking shaft. One of these is short and must be installed at top, nearest starter center line. Insertion of a long bolt in this position will result in it forcing its way through into the clutch housing, causing failure of the starter. The starter is placarded to this effect.

When routing the propeller feathering line and the flexible conduit to the propeller governor, clearance for removal of the cuno oil strainer on the engine accessory case should be allowed by keeping the flexible lines very low on the inside of the engine mount tube. To pass these lines through the engine intercylinder baffle, it is necessary only to bend the baffle out from the cylinder, no cut-out in the baffle is required.

The magneto blast tubes are installed by removing the small cover plate screwed in place on the engine intercylinder baffle. Support of the tube at the front end is obtained by removing one of the engine nose section attaching bolts, placing the blast tube bracket under its head and reinserting.

There are fourteen (14) cowl support brackets mounted on the rocker box studs. Thirteen brackets are attached with elastic stop nuts; the fourteenth, on the upper left front cylinder, incorporates a pulley bracket and must be attached with castle nuts and cotter pins. Elastic stop nuts are not suitable on the fourteenth bracket due to the extra load and vibration imposed on same.

Access to all the accessories is good. The removal of the cuno oil strainer, the supercharger rear case oil strainer, and the sump drain plug may all be accomplished with everything in place other than the cowling sheets.

ENGINE AND MOUNT REMOVAL

Removal of the power plant installation from the airplane for servicing may be accomplished by removing either the entire engine and mount assembly, or by removing the engine alone. In either case, the only support used is the engine hoisting sling provided by the Wright Co. The sling is attached to the engine rocker boxes as shown in Fig. 1.

Removal of the entire engine and mount assembly will require disconnecting all engine control rods, propeller governor control cables, and all tubing and conduits entering the nacelle. In addition, all cowling sheets must be removed, and the accessory cowling fillets, formers and the tailpipe "Y" shroud must be disconnected. Complete removal of these items is recommended to avoid the possibility of damage as the engine moves about. When the foregoing operations have been completed, tension may be put on the engine sling until it is seen by watching the rubber mountings, that the engine weight is off the mount. The four engine mount attaching nuts at the firewall may then be removed. If the mount tends to bind, which it may do after long periods of service, work the engine hoist slightly upward. This operation should pull the assembly away from the two bottom bolts. Before lowering the assembly insert a screw driver or bar between the lower mount lugs and the firewall to prevent reseating the lugs. The weight of the engine may then be allowed to pull the mount away from the two top bolts.

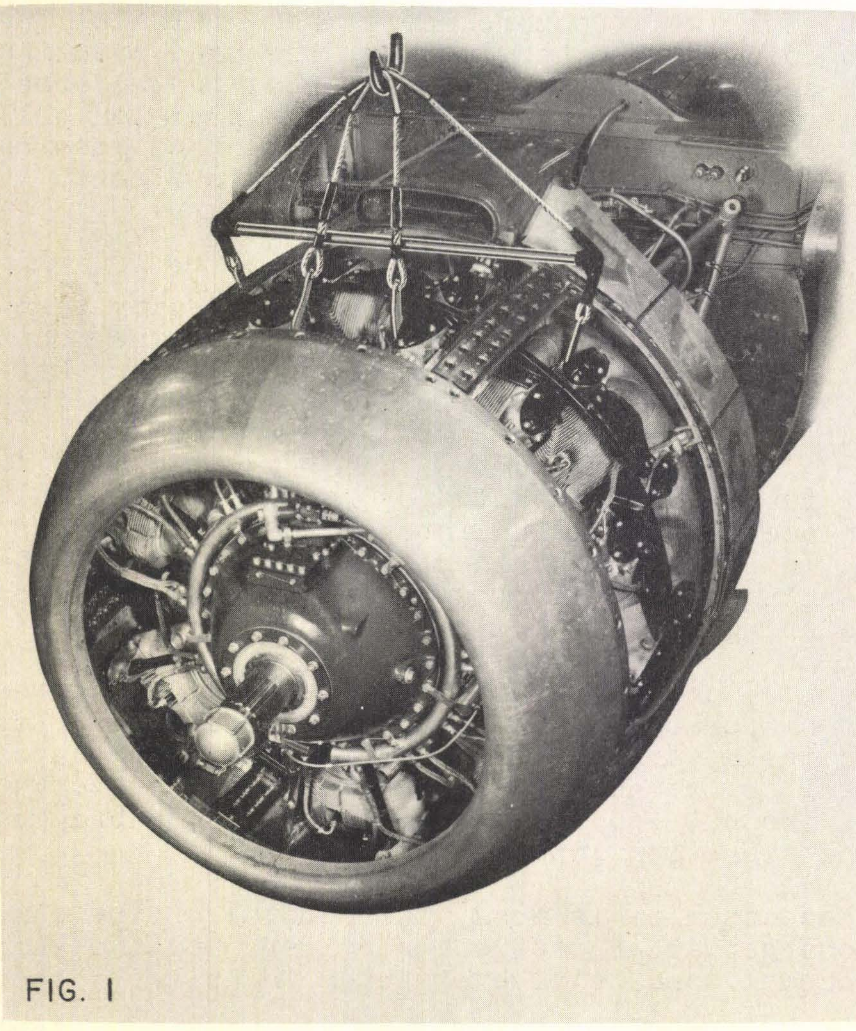


FIG. I

Reassembly of the engine and mount to the airplane will be essentially the reverse of the operations just described. The procedure used at this factory in replacing the mount on the airplane is to hoist the engine to the correct height, move the mount back against the firewall, and then, by moving the hoist still farther aft, cause the engine to "lean" on the firewall. When the two top mount fittings have been sec-

ured to the airplane, the hoist may be slowly slackened, allowing the weight of the installation to slide the lower fittings home. Reassembly of all disconnected parts may then follow. In this connection it should be noted that the apparent haphazard scattering of the unions in the various lines was done intentionally, to make remote the possibility of two lines of the same diameter being crossed when reassembled.

ENGINE REMOVAL

When it is desired to remove the engine only, all the cowling sheets must be removed first. Then, as outlined in the foregoing procedure, all lines, rods, cables and conduits from the engine to the firewall or engine mount must be disconnected in such a manner that the engine will not be held to the mount. Disconnect the rods attaching all cowl flaps to the operating bellcranks. The next step is to remove the carburetor, carburetor adapter and the fuel pump. After placing tension on the sling so that the engine hangs on the sling instead of the engine mount, disconnect the bonding strips between engine and mount. Remove the bolts which attach the Lord mounting bushings to the hangers, leaving the hangers with the engine mount. The engine may then be drawn straight forward. Reassembly is but the reverse of the procedure discussed.

COWLING

The cowling installation of this airplane has been designed with three objectives; clean lines with consequent efficiency, simplicity, and accessibility. The only protrusions are the carburetor air intake scoop and the exhaust collector "Y". Construction follows one simple standard throughout, and, as may be seen by the illustration, the cowling may be readily removed, in small panels, to lay the entire nacelle bare. The close spacing of the Dzus buttons on the ring cowling may cause some curiosity. They were so located, however, in consideration of the high air loads on these sheets in high speed flight.

The cowling sheets are made throughout of 24ST, alclad sheet, with spot-welded strips of the same material reinforcing the edges and Dzus button cut-outs. Sheets are in general .040 thick, but require the reinforcements around the edges and corners to forestall the possibility of cracks resulting from fatigue. In addition, the panels are made more rigid for handling.

Accessory and nose ring sheets are supported along their fore and aft edges by formers of .025 stainless steel sheet, suitably reinforced at points of attachment to the airplane. Around the circumference of the cowling, support is provided by the fixed cowling ring or "DISHPAN", and the firewall.

The engine nose ring cowling is attached semi-permanently to the engine rocker boxes with shock absorbing Lord bushings. The bushings also allow for the expansion in diameter of the engine as it heats up. Removal of this assembly is not required for servicing, as it is completely forward of the cylinders. The cowling mat-

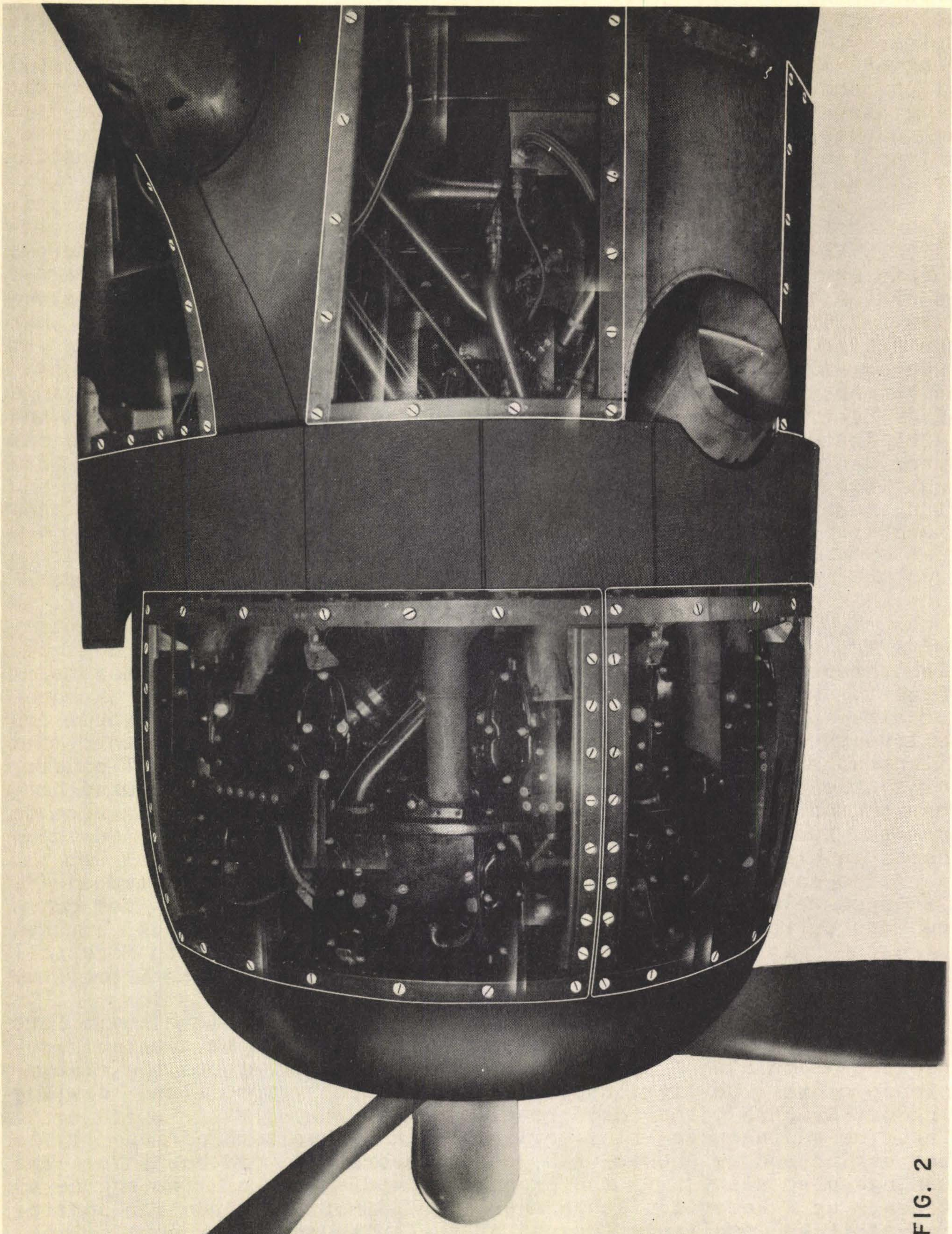


FIG. 2

erial is .040 24ST,alclad sheet with alclad and C.M. steel reinforcing and mounting brackets.

Attached to the rear row cylinder rocker boxes is the flap ring assembly, which serves the dual purpose of supporting the cowl flaps, and the trailing edge of the ring cowl sheets. Like the nose ring, this assembly is mounted with Lord rubber bushings, and does not normally require removal. It consists simply of a 24ST,extruded, "L" section to which are attached chrome molybdenum steel mounting brackets, Dzus springs, and the forged steel flap hinges.

Just aft of the flap ring, protecting and separating the engine and exhaust collector ring, is a diaphragm air seal. This consists of two assemblies; an engine baffle, mounted on the engine,and a fixed cowl ring, mounted on the engine mount. The engine baffle is simply a flat disc of 24ST sheet, cut to fit the engine accessory case and with cut-outs for the Lord mount, magneto blast tubes, and ignition conduits. The engine fixed cowl ring is a spot-welded assembly of stainless steel sheet construction,to withstand the heat of the adjacent exhaust collector ring. In addition to its function as an air seal, it supports the front edge of the accessory cowl sheets, and is heavily reinforced to take the loads imposed by the cowl flap operating linkage which it supports.This assembly is bolted to the mount and is not removed for servicing.

As may be seen from the illustration, parts normally requiring access may be readily reached through the removable panels which are Dzus buttoned in place. The oil tank filler opening cap, requiring frequent access, is provided with a special door for that purpose.

Since the nacelle, because of the tricycle landing gear, is close to the ground, no provisions have been made for working platforms.The accessory cowling formers are reinforced for use as steps. The formers over the cylinder heads, however, are not to be used as steps and are placarded to that effect.

The installation of the fixed ring cowl is worthy of note inasmuch as it presents several difficulties. It will be noted that this assembly is supported by the engine mount ring, and by four cast brackets on the fore and aft engine mount tubes. In addition, the carburetor air mixing chamber is supported by the fixed cowl, and by a link to the mount ring. The following procedure is recommended when installing these parts. Set up fixed cowl ring and all four support castings, leaving all bolts loose. Set the carburetor air mixing chamber,with its support link in place, and tighten down. Then work uniformly around the entire ring, tightening all bolts. Failure to install the chamber before tightening will result in misalignment of this part. Oversize,or slotted holes,have been provided all around the ring to provide for any fabrication variations.

The cowling has been reinforced to withstand the loads which will be imposed upon it. However, as service hours accumulate failures may occur. The removable sheets may crack at corners, around Dzus buttons, and attaching screws and bolts. Standard repair procedure may be followed.In other words,if the crack is small,drill a #40 hole at the end of it and rivet or spot-weld underneath a small reinforcing doubler of .040 alclad sheet. If several cracks appear, or if the metal disintegrates around a Dzus stud or screw, remove that area of the sheet and make a smooth edged hole with no sharp corners. A patch of .040, 24ST alclad may then be riveted or

spot-welded over this with the Dzus stud or screw hole in the patch. Failures in the cowling formers may be treated in a similar manner. The formers are of corrosion resistant, steel sheet and gas welding may be employed to close any small cracks. The nose ring, flap ring and fixed cowl ring are unlikely to show failures, although a check for fatigue cracks in the various support brackets is advisable.

COWLING FLAPS

One portion of the cowling worthy of detailed discussion is the cowling flap installation. The flaps, mounted on the ring previously mentioned, are of spot-welded, 24ST, alclad sheet construction, in the form of a hollow box, with forged steel hinge brackets riveted in place. One flap, directly opposite the exhaust collector tailpipe "Y" on each engine, is of spot-welded, stainless steel construction to withstand the heat at the location.

The flaps are actuated by means of a hydraulically powered bellcrank and push-pull rod linkage, supported on the fixed cowl ring. Movement of the flaps is controlled from the cockpit by means of a three-position lever, one for each engine, located at the base of the control pedestal. A flap position indicator is not provided, inasmuch as flaps are visible from the cockpit. To open or close the cowl flaps, move the control lever all the way to "OPEN" or "CLOSE", and hold the lever in that position until the flaps reach the desired position. Then return the lever to neutral. In the event the flaps do not respond to the control while engines are running, do not attempt to move them with the hand hydraulic pump. Failure is indication of a broken line or connection, and use of the hand pump would merely pump hydraulic fluid overboard. All bellcranks in the flap operating mechanism are of ball bearing design, having long lever arms and bushed holes for the clevis rod ends. Thus the effect of wear in service is minimized in its effect on the operation of the flaps. Bellcrank connecting rods are of C. M. steel tube with clevis ends, while those from the bellcranks to the flaps are of steel rod with ball bearing rod ends.

The rods and bellcranks will require no lubrication as their bearings are of the grease sealed type. The clevis rod ends, flap hinges, and hydraulic strut hinges all require lubrication as their bearings are of the plain type.

In the event that the installation must be dismantled and reassembled, it is strongly urged, even though a drawing be available, that all the rods and bellcranks be numbered or otherwise identified with their position in the assembly. It is very easy to scramble the rods upon reassembly, thus destroying the synchronization necessary in the operation of the flaps. This has happened several times in our shop, resulting in destruction of several parts each time operation was attempted.

When the installation is complete, it should be operated several times, slowly, by hand, with the hydraulic strut disconnected. Watch the operation carefully, and adjust the ball bearing rods until adjacent flaps are all synchronized and working smoothly. With the flaps closed, a uniform clearance of one and three-sixteenths

(1-3/16) inches should exist between the flaps and the fixed cowl all the way around. When the flaps are opened, however, it will be found that the upper ones open much less than those around the lower half of the cowling. This is done to keep a smoother air flow over the wing and tail.

No adjustment is provided on the rods connecting the various bellcranks. These are made to a predetermined length and any attempt at adjustment on these would only throw the whole system out of synchronization. Adjustment is provided on rods connecting bellcranks to cowl flaps.

The stainless steel flap over the tailpipe "Y" is fixed, it being difficult to reach this flap with the operating linkage. The links supporting the trailing edge of this flap must be attached with clevis bolts which will permit them to pivot, allowing for the lateral motion of the flap from engine vibration.

Trouble, if experienced in the flap installation, will occur principally in failure of the sheet metal parts. These may be repaired in the manner discussed earlier. Cracks extending into the box section of the flap will be very difficult to repair and replacement of flap is recommended when its condition warrants.

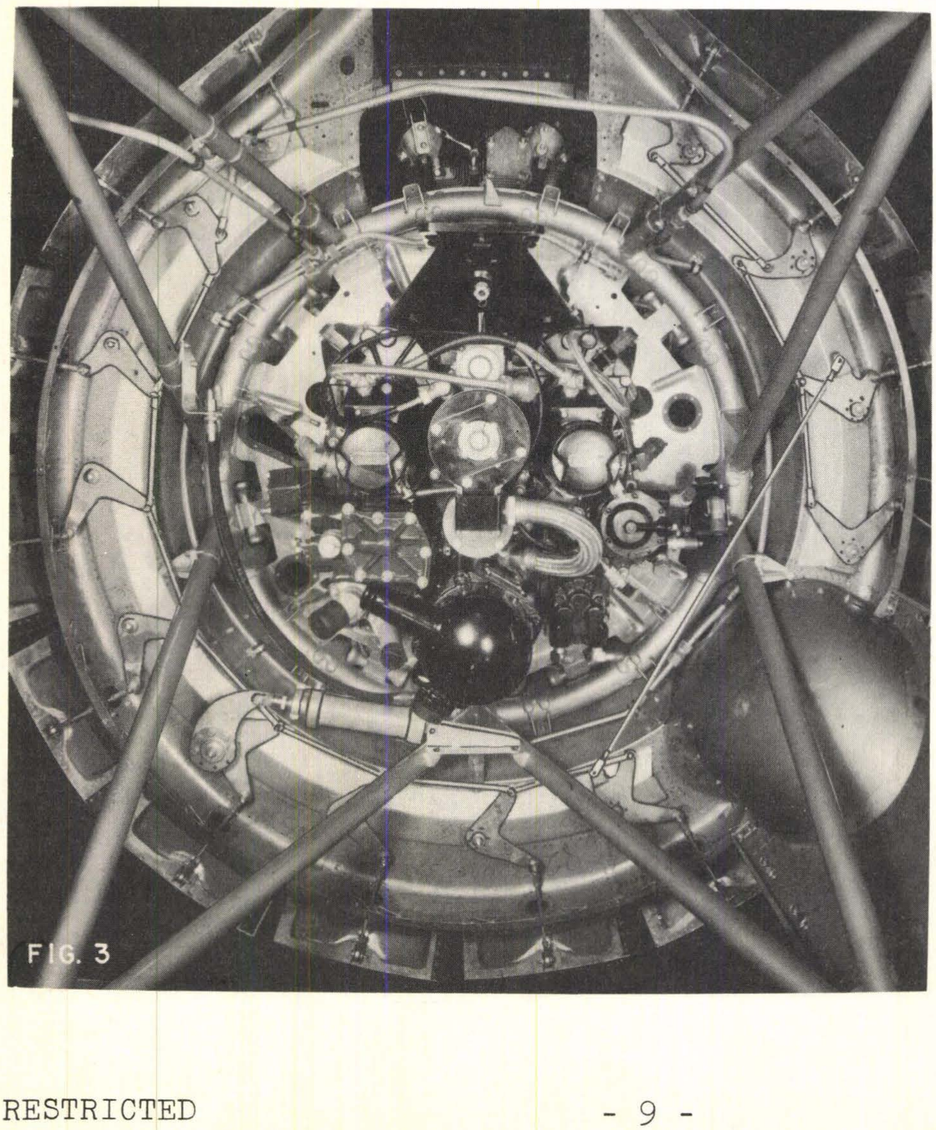


FIG. 3

The collector tailpipe shrouds, fabricated of spot-welded, stainless steel sheet, present a separate repair problem from that offered by the rest of the cowling. Although the shrouds have been heavily reinforced in corners, at bolt holes,etc., they are subject to considerable heat from the exhaust collector tailpipe. Failure is, therefore, a possibility. Cracks in the tailpipe shrouds, depending upon their size and location, may be closed by gas-welding or covered with a stainless steel reinforcement patch, spot-welded, gas-welded or riveted in position.

CARBURETOR AIR INDUCTION

We will next consider the carburetor air induction system, since it is tied in with the cowling installation. This system consists of a cast aluminum alloy air mixing chamber, Fig.4, air gates, and a neoprene duct connecting it to the carburetor. The air gates in the chamber have two positions only, one for normal operation and one for operation under icing conditions. In the first condition, the air is taken from the slipstream outside the cowling on top of the nacelle. Under icing conditions, this intake is closed by the two gates inside the chamber, and hot air is taken from within the cowling where it has been heated by passing between the cylinders and over the exhaust collector. Assembly of the chamber to the airplane has already been discussed. When assembling the neoprene duct to the carburetor and to the mixing chamber, care should be taken to tighten the bolts and nuts very lightly. Otherwise, the neoprene will be forced out from under the washers, and splits will develop. The installation will require but little service attention. The neoprene duct should be checked for splits, and the air gate bearings will require lubrication. When disassembled, the air gate should be checked for wear. As the clearance between shafts and bearings increases, the rate of wear goes up rapidly. Worn shafts should be replaced.

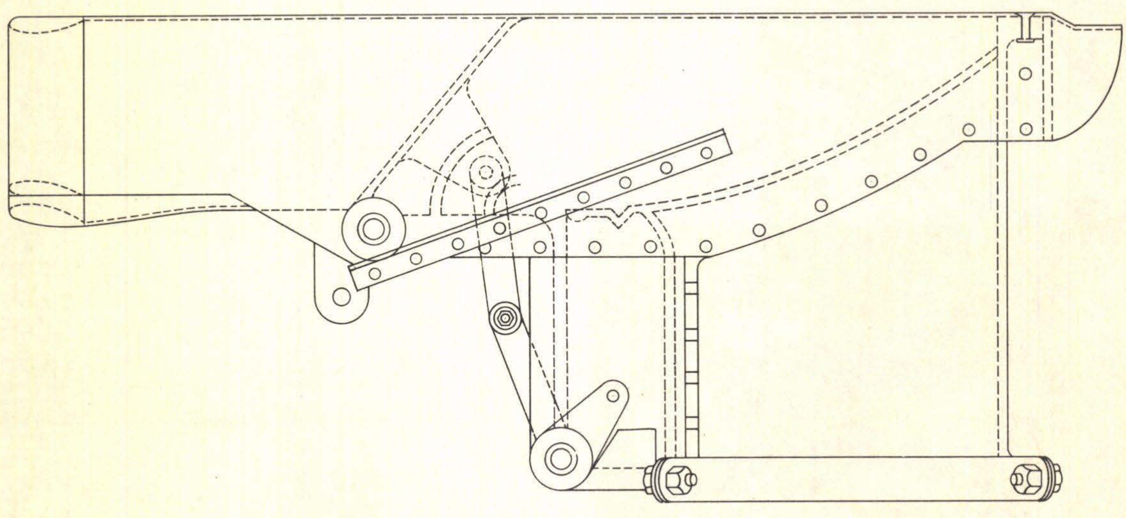


FIG. 4 CARBURETOR AIR MIXING CHAMBER

ENGINE MOUNTS

The engine installation is supported by an engine mount constructed of C. M. steel tubing. The mount is attached to the firewall at four points with one-half (1/2) inch diameter special bolts, each of which is subject to tension only; shear loads are carried by the fittings in which the bolts are mounted. Torsional or twisting vibration of the engine is absorbed through the use of type RL-25 Lord

Suspension Mountings, Fig. 5. These mountings cushion the sharp engine vibrations and allow the engine great latitude in torsional movement thus prolonging the life of the engine and the airplane and providing a smoother running installation. Fore and aft or lateral motion of the engine is negligible.

As per Air Corps Technical Order No. 01-1-58 dated October 3, 1940, Lord mountings are to be installed with a torsion wrench. Assemble the seven (7) suspension mounting yokes (without the bushings) to the mount ring before hoisting the engine into place. The bolt attaching the mounting assembly to the engine mount ring is drawn up until the yoke binds, then backed off just enough so that the yoke will fall slowly of its own weight. This will allow proper clearance for the two tapered roller bearings, upon which the yoke pivots. The rubber bushings are to be installed on the engine, and then the two attaching nuts are drawn down to four hundred (400) inch pounds of torque or twist. Swing the engine into place and attach the rubber mounting to the yoke. This bolt, which passes through the center of the rubber bushing is drawn down to three hundred fifty (350) inch pounds of torque.

When attaching the Lord mount assembly to the engine, it should be noted that it has a front and rear side, and is so marked on the housing. The shear bushing is pressed into the housing, having a shoulder on one end. When the assembly is properly mounted on the engine, the torque of the engine presses it in this same direction, the shoulder providing a stop.

A Zerk fitting is provided on the yoke, to lubricate the two roller bearings. This should receive attention as required to keep bearings visibly filled with grease. There is little trouble to be expected of this unit. The only trouble experienced in our plant has been the failure of the rubber to metal bonding on the shear bushing; but those failing had seen very severe operating conditions on the engine ground test stand.

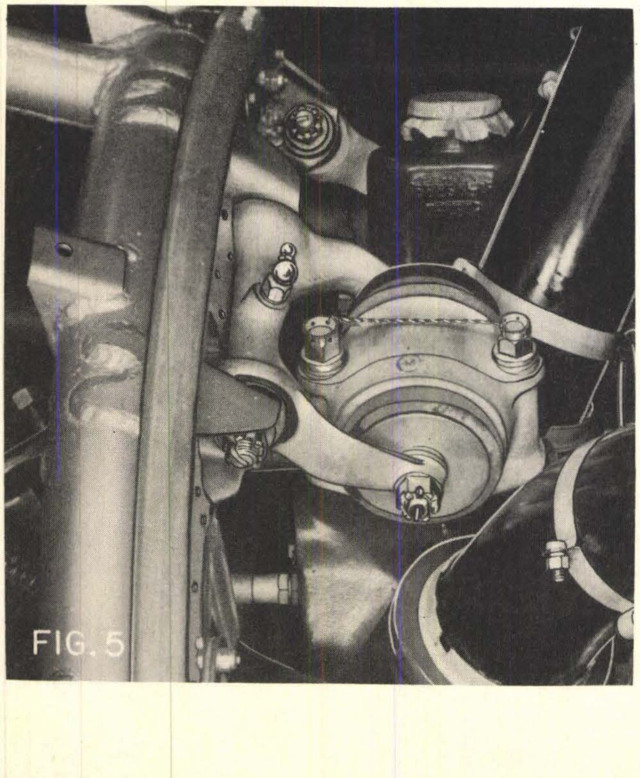
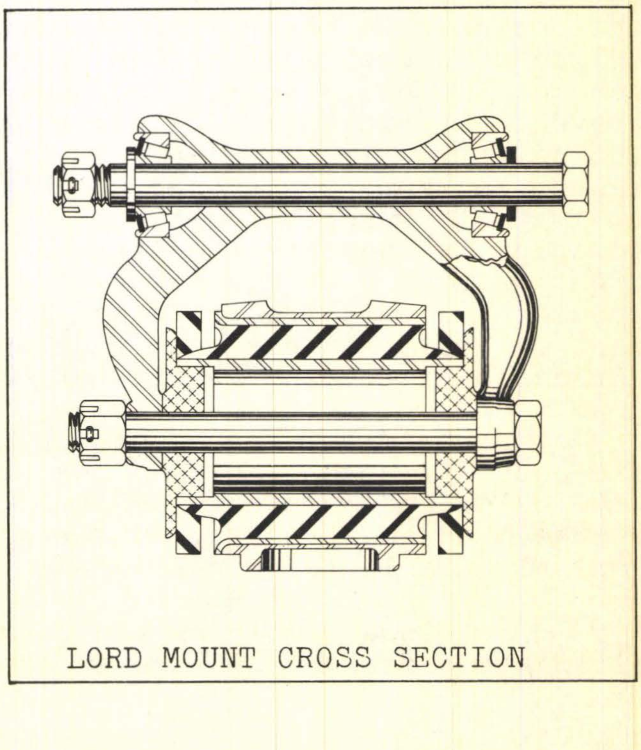


FIG. 5



LORD MOUNT CROSS SECTION

EXHAUST COLLECTOR

The exhaust collector installation, Fig. 6, on this airplane is one presenting many little problems in servicing and installation. As may be seen, the collector consists of a ring, broken up into segments, with stacks forward to the cylinders, and a single outlet tailpipe, located on the outboard side of each nacelle. It is constructed entirely of soft corrosion resistant steel, sheet, tubing, and bar stock. Most of the assembly is made of .050 thick material;while some highly stressed parts are of .063,and some lightly stressed parts are of .043. To eliminate the rapid wear resulting when a collector ring is mounted on the stationary engine mount, and connected to a vibrating engine, this ring assembly has been kept as light as possible, and is mounted directly on the engine and supported by the exhaust port flanges. The "Y" section of the collector ring, because of its larger size and greater overhang to the rear of the port flanges, has been supplied with a shock absorbing brace to the engine accessory case, thus giving it a three point support. Because of the expansion and contraction taking place in the engine and in the collector ring, it has been broken up to supply the expansion joints, as shown in Fig. 6. Each segment, except the "Y" section, has one short and one long stack on it; the short one providing the support,while the long one is provided with a telescoping expansion joint. The segments are joined by split sleeves, which are slipped over the bead on one side of the joint, and then tightened into a tube.

The amount of service obtainable from these collectors will depend greatly upon the care used when installing them.

The collector is so designed that,when properly assembled,with all clamps tightened, etc., any of the sleeves or the connector may be freely moved by hand. The split sleeves around the collector ring are designed to have .020 to .030 clearance on the diameter of the collector segments, when their bolts are tightened and the two halves of the bolt bosses are firmly together. This is necessary to prevent the expanding collector segments from binding on the sleeve and splitting it. If clearance is not obtainable, check the two collector segments for proper alignment. If this exists, a washer or two may be inserted between the halves of the sleeve bolt bosses, to slightly increase the diameter of the sleeve, when the bolts are tightened. The stacks to the front cylinders have slip joints which should also be a free sliding fit. If these bind, it is because one part or the other has been made egg-shaped by handling. This may be corrected by tapping gently into shape.

On the other hand, excessive clearances at the various joints are equally undesirable. Clearances in excess of the .020 to .030 will allow hot exhaust gases to escape in quantity sufficient to overheat adjacent parts. The rear set of spark plug wiring is particularly liable to be burned and caused to fail.

Care in assembly of the segments to the engine will do much to eliminate trouble when the sleeves are fitted. The flanges at the

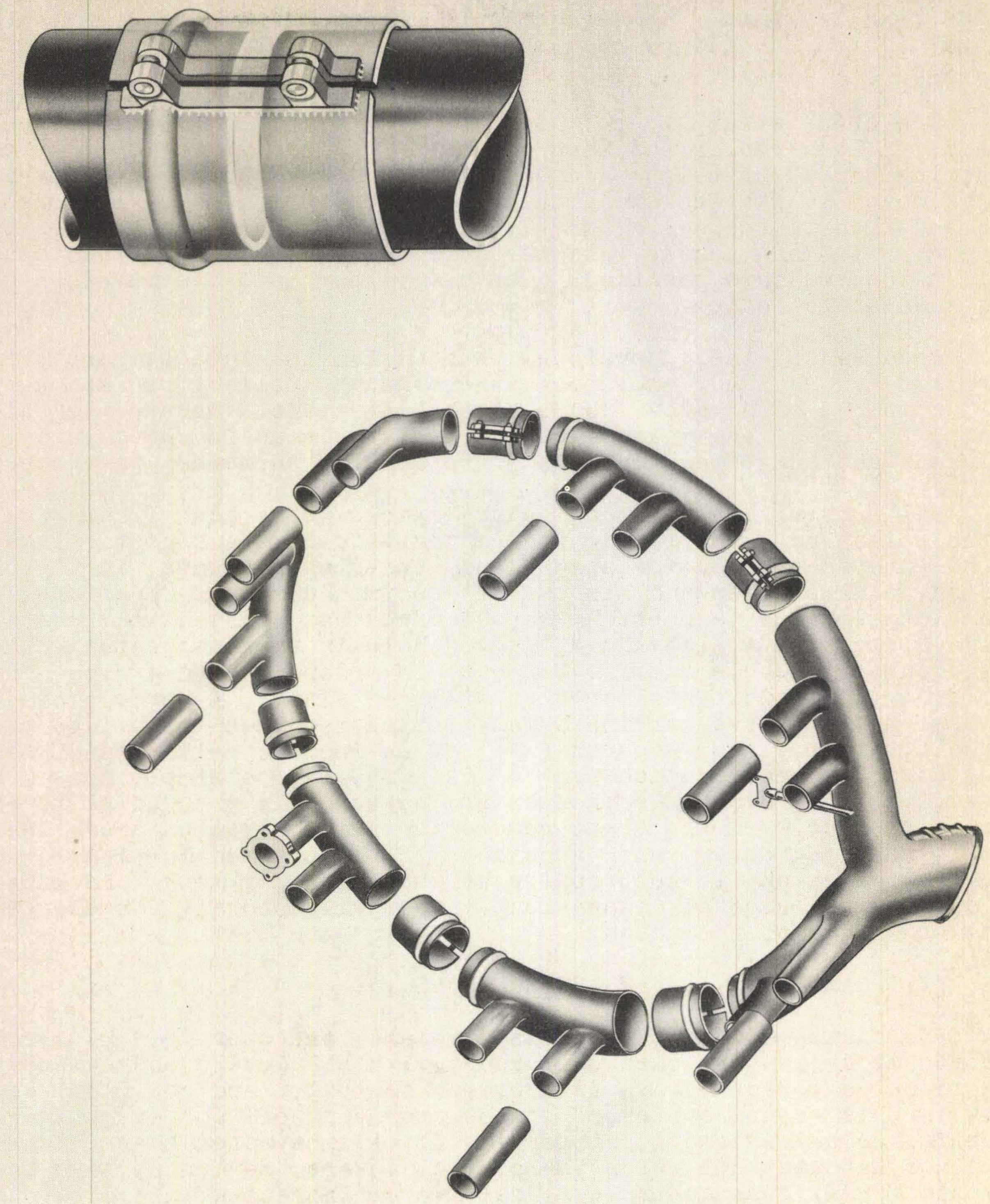


FIG. 6 EXPLODED VIEW OF COLLECTOR

cylinder exhaust ports seat on a one-sixteenth (1/16) of an inch copper asbestos gasket, hence the nuts must be drawn down uniformly or the gasket may compress unevenly. This could cause misalignment of the ring segments. In attaching the "Y" section, it is advisable not to tighten the flange nuts until the brace strut to the accessory case is installed.

The brace strut to the accessory case on the airplane incorporates a Lord rubber absorber to dampen engine vibration. Before attaching this strut loosen the clamp so that the rubber bushing can be moved in its socket. Attach the assembly to the engine crankcase and then to the collector "Y" section. Tighten the nuts on the "Y" port flanges and as this is done the two halves of the brace will telescope into position. The clamp on the brace may then be tightened and safetied.

Because of their continual subjection to high temperatures, corrosive gases and vibration, the exhaust collectors are short lived compared with other parts of the airplane. As service time mounts, failures are likely. Hence, this discussion on types of failures and suggested methods of repair for them when they occur.

Failures will show up as jagged cracks to be most likely found in the following locations: At the individual stack port flanges, at the intersection of the stacks and the ring segments, in the expansion joint sleeves and in the "Y" section crotch. Occasionally, after long service, a portion where a crack has started will practically disintegrate, leaving a jagged hole in the collector. When this occurs, the hole must be cut out in order to have a clean outline from which additional cracks will not start. A patch plate of the same gauge as the portion which failed may then be welded over the hole, leaving a one-fourth (1/4) of an inch lap all around. Simple cracks, the most common type of failure, may be simply closed by gas-welding. If a part is thought to be so badly cracked as to require a doubler over the area, remove the entire cracked area, leave a small hole and cover with a patch. If the cracked portion is not removed, the patch is kept cooler by the layer of metal underneath and due to the unequal expansion, cracks will shortly develop all around the edge of the patch.

ENGINE CONTROLS

The engine controls on this airplane are operated by a combination of cables and push-pull rods, with all levers conveniently grouped on a pedestal, Fig. 7, between the pilot and co-pilot. Controls in this group consist of carburetor air, oil cooler, mixture, throttle, propeller and supercharger. It will be noted that friction locks or notches into which the control levers may snap, have been provided for all the controls. Positive control is obtained through the general use of steel flexible cables. Push-pull rods, however, are used inside the cockpit control pedestal and to connect the carburetor air, mixture, throttle and supercharger controls from firewall to engine. Thus cables need not be disturbed during engine replacement. In each nacelle, a cable is used for control of the prop-

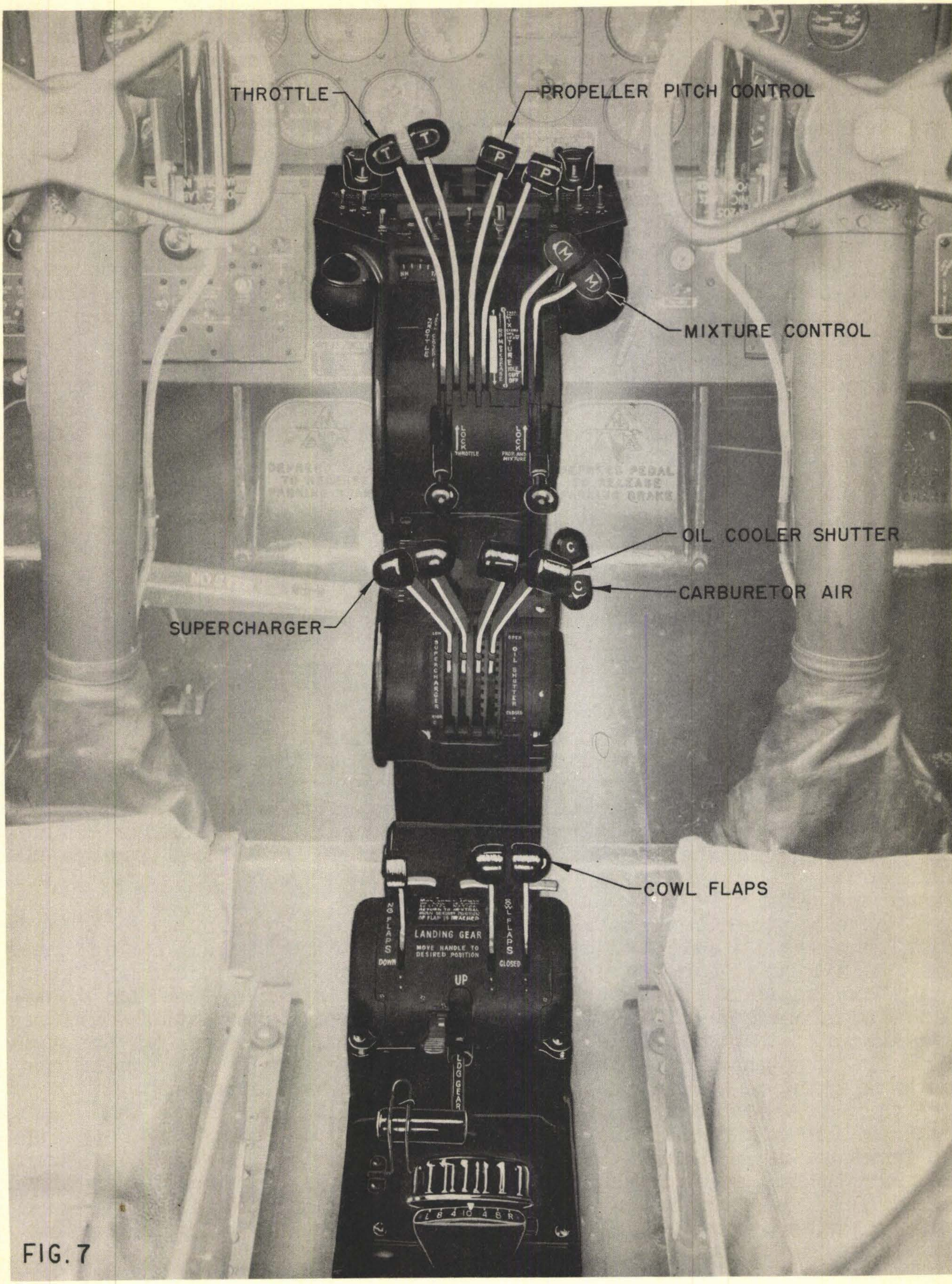

THROTTLE
PROPELLER PITCH CONTROL
MIXTURE CONTROL
OIL COOLER SHUTTER
CARBURETOR AIR
SUPERCHARGER
COWL FLAPS
LANDING GEAR
MOVE HANDLE TO DESIRED POSITION
UP
DOWN
CLOSED

FIG. 7

eller governor. The reason for this arrangement is because of the close clearance in passing through the engine cylinder head fins, and also, so that as the engine pulls forward, the propeller governor position will not change.

Referring to our perspective sketch, Fig. 8, the general routing of the system may be seen at a glance. The control cables leave the base of the pedestal, go aft along the underside of the pilot's floor (in the nose wheel well), then across the rear of the nose wheel well to the right side of the airplane where they again head aft along the side of the navigator's compartment. At the leading edge of the wing, the cables cut sharply upward, separate into right and left-hand controls, and pass through a tunnel in the wing leading edge to the nacelles. Here all except the oil cooler air shutter control turn forward and terminate at the engine. The oil cooler shutter control passes on into the outer wing panel and then aft to the shutters.

The controls are completely accessible for servicing. Paneling may be quickly stripped from the pedestal for adjustments. To gain access to the nose whell well, it is necessary to open the door which is normally closed when the landing gear is down. A bolt encircled with a red line is located on this door and when the bolt is removed, the door will be free to swing open. From this opening aft, the controls are accessible inside the navigator's compartment where a sheet metal cover must first be removed. The cables in the wing may be reached by removing a panel which exposes the entire underside of the wing tunnel. The air cooler shutter controls in the outer panel, may be reached through hand holes in the lower wing skin.

ENGINE CONTROL OPERATION

The throttle is strictly conventional in operation, the forward position being open and the rear closed. The Holley carburetors on these engines have a balanced throttle which counteracts the air load.

The mixture control is automatic within the carburetor. Three positions may be selected by the pilot at the controls, however; these are "Full Rich" (forward position), "Cruising Lean" (middle position) and "Idle Cut-Off" (rear position). The positions are marked on the pedestal and may be located by feel. In the event of control failure, the mixture will continue in whatever range it was set at the time of failure. (Complete information on the proper use of all these controls will be given in the lecture on Engine Performance.)

The RPM at which the propeller is to be operated is established by means of a manual control to the propeller governor. Forward is "HIGH RPM", aft is "LOW RPM". An electric switch is provided which controls feathering and unfeathering of the propeller. (A complete discussion of feathering will be given in the Engine Performance Lecture.)

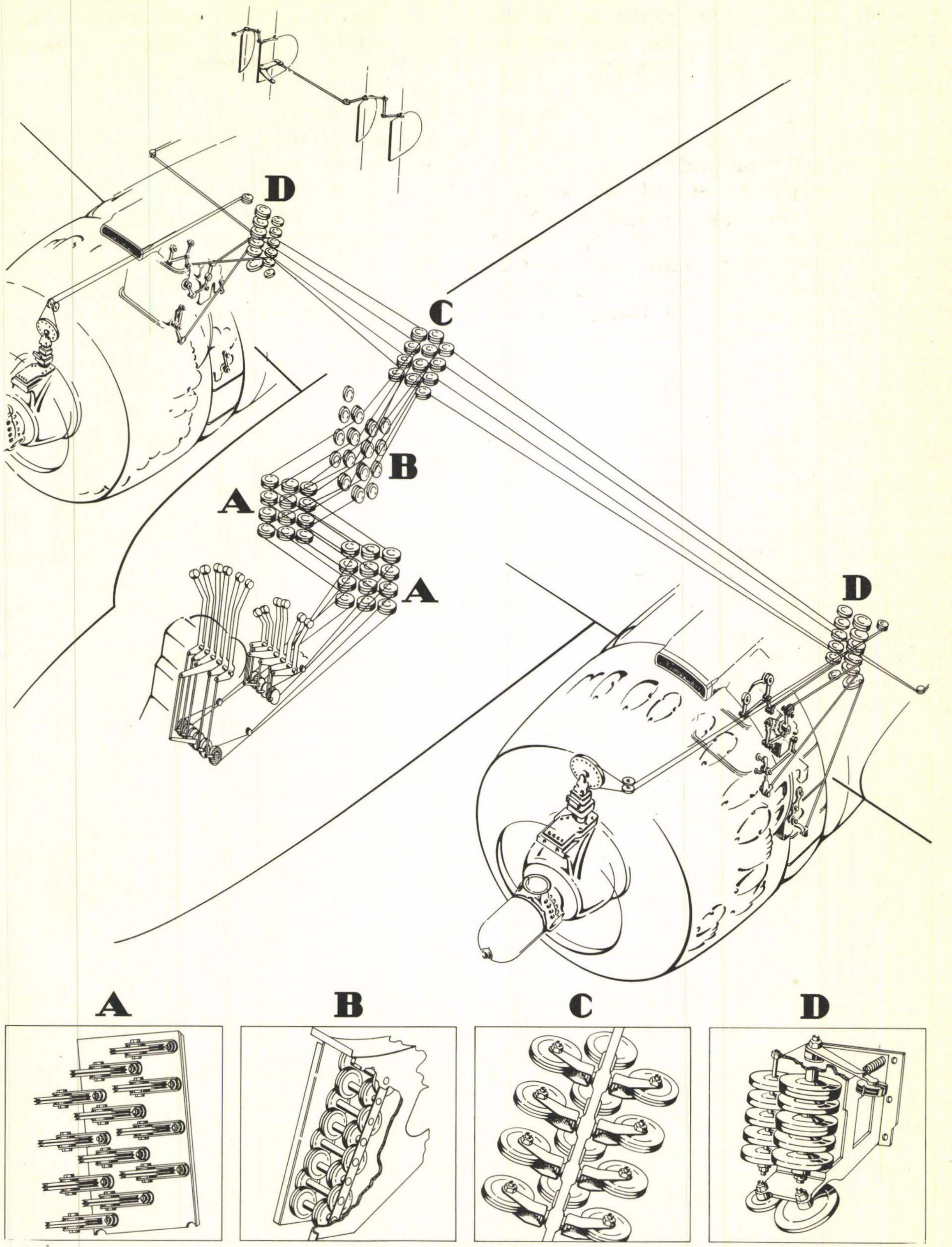


FIG. 8 ENGINE CONTROL DIAGRAM

The carburetor air control is two-position only, being "Cold" forward, and "Hot" aft. Normal flying is always done with this control in the "cold" position, the "Hot" position being used only when operating in icing conditions. The air gates will automatically assume a midway position in case the control is severed.

The supercharger is also a two-position control. It operates an oil valve in the engine oil pump, which selects one of two gear ratios for the built-in blower. The low ratio (control forward) is 7.06:1 and the high ratio (control aft) is 10.06:1. The engines on the B-25C airplanes incorporate an over-center toggle control, which will positively keep the control in one position or the other, in the event of control failure. No creeping will occur because of this toggle control and the notch supplied at the control pedestal.

The oil cooler shutter control levers in the pedestal travel in a serrated slot, permitting them to be positively set at a number of intermediate positions between "OPEN" (forward) and "CLOSED" (rear). The control is spring-loaded at the shutters to make them assume an open position in the event of control failure. The shutters are normally set "OPEN". For quick warm up, when propellers are feathered, or when flying in very cold air, they may be closed as required to maintain desired oil temperatures.

Once properly adjusted the control system should require but little servicing. As noted before, the ball bearings will not require lubrication. The only parts requiring lubrication attention are several Zerk fittings on the control pedestal bellcrank groups, the oil cooler shutter bearings and the carburetor air mixing chamber bearings. In some instances, needle bearings have been substituted for ball bearings due to temporary shortage. The needle bearings will require lubrication. A smear of graphite lubricant on the cables where they pass through the various fairleads, will prolong their life and give smoother control action.

If the rods, cables and bellcranks must be removed from the airplane, identification of each and every one, and its location in the airplane should by all means be established. This will save considerable time in assembly.

ADJUSTMENT OF THE ENGINE CONTROL SYSTEM

The rods and bellcranks are set up at the factory using jigs to hold the bellcranks in place while the rods are adjusted between them. Starting with the pedestal levers in neutral (mid-position of travel) all bellcranks are set square with the airplane axis. Final adjustment for spring back or synchronization is made on the rod assemblies in the nacelle.

When reassembling the system, block the pedestal in neutral. If the rod settings have not been altered, each bellcrank in the pedestal will automatically assume its correct right angle position.

It is a relatively simple matter to thread the cables through all pulleys except through the large pulley housing in the navigator's compartment. Due to congestion in this area, it has been found advisable to install the cables through this housing first. This will provide one turnbuckle assembly for each control on each side of the housing for adjustment purposes. After the threading has been completed, cables should be rigged to a tension of fifty (50) pounds. This is a tentative figure established because of the warmer temperatures at which the cables will be installed and because of the relatively greater slackening which will take place as the airplane flies in different weather conditions. This tension will be modified later if such action is found to be desirable.

The propeller governor cable from the firewall to the governor is rigged at fifteen (15) pounds. At the firewall and at the governor, it is locked to the pulleys by small clips, which pinch the cable against the pulley flange. That on the propeller governor pulley is poorly designed and will tend to cut the cable if drawn up too tight. Our shop has been cautioned on this, and the airplanes should be delivered with the installation correctly made. As service hours accumulate, however, it will be advisable to check at this point for possible frayed strands in the cable. If they are found, replacement is in order.

OIL SYSTEM

An independent oil system, Fig. 9, is provided for each engine. Each consists essentially of an oil compartment, two automatic temperature regulators, an engine-driven oil pump, an oil dilution system, and a special high pressure supply of oil for propeller feathering.

The storage compartment on the B-25C airplane may be filled by opening a Dzus fastened door on top of the nacelle just aft of the firewall,and unscrewing the filler cap located on the top of the oil tank. A dipstick graduated in gallons is provided beside the filler cap. This must be checked to determine when the compartment has been filled to capacity. The maximum oil level on the first 383rd B-25C airplane is 36.5 gallons.The maximum oil level on the 384th and subsequent B-25C is 37.5 gallons. This oil level should not be exceeded as to do so would reduce the available foaming space.Fillers are fitted with overflow drain lines to the bottom of the nacelle,and it is suggested that a receptacle be placed underneath the nacelle when filling the oil compartments. The oil stowage compartments,Fig.9,are built integral with the wing center section, just behind the front spar.An accelerated warm-up compartment is built in.The engine lubricating oil is withdrawn from a short standpipe in the compartment sump.Oil remaining below the standpipe intake level assures a source of oil for the propeller feathering system,in the event of an engine failure causing the tank to be emptied. This remaining oil is drawn off through a separate line,entering the sump at a lower point.Leaving the compartment, the engine lubricating oil passes down through the firewall to the "Y" drain valve, which can drain the system exclusive of the oil temperature regulators,and the lines to them from the engine. From the "Y" drain valve, the oil proceeds to the engine pump in the rear case of the engine. A relief valve at this point

may be adjusted to set the desired engine oil pressure. Passing through the engine, the oil is returned aft to the two oil temperature regulators installed in the outer panel. These two regulators are each ten (10) inches in diameter, arranged in parallel (i.e., half of the oil goes through each cooler), with type D-5 thermostatic valves fitted. Passing through the temperature regulators, the oil returns to the storage compartment, where the cycle starts over again. To aid cold weather starting, an oil dilution system is provided, taking fuel under pressure from the carburetor through a solenoid-operated valve on the firewall, thence to the "Y" drain valve, where it is mixed with the oil. By injecting the gasoline at this point, where it must flow through the entire system before reaching the tank, oil of reduced viscosity is left in the entire system, providing much greater ease of starting. The propeller feathering supply of oil is drawn from the reserve oil in the sump previously described. From here it flows to the electrically-driven feathering pump, which forces the oil into the propeller at a pressure of five hundred (500) to seven hundred (700) pounds per square inch. When the propeller is unfeathered, the oil does not return through this line, but instead passes through the propeller governor into the engine sump, from where it is returned to the storage compartment through the engine lubricating system.

OIL SYSTEM SERVICING

Accessibility to all parts of the system has been provided. The interior of the storage compartment may be reached by removing the large sump bolted to its lower side. The oil temperature regulators and their air shutters are available through large access doors directly under them in the lower skin of the outer panel. The D-5 relief valves on the temperature regulators are not adjustable, being set at time of manufacture for an established temperature range. They are, however, installed on the lower side of the regulators so as to be readily replaceable through the access doors.

Flying with the oil temperature regulator air shutter wide open in cold weather may cause the oil to congeal in the regulator cores, forcing the circulating oil to by-pass them. This condition will thus be indicated by excessive oil temperatures, and may be alleviated by closing the shutters for about two minutes; then slowly reopening until the desired oil temperature is attained.

In the event of an engine failure, such as bearing or gear breakage, in which metal particles are drawn into the oil system, it will be necessary to dismantle and thoroughly clean the entire system. It is almost an impossibility to really clean the oil temperature regulators. To safeguard the new or repaired engine, it is recommended that the oil coolers be replaced after such a failure unless the Air Corps has another policy.

The dilution system solenoid-operated valve may sometime begin to seat poorly. This will be indicated by gasoline odors from the engine breather pipe when the oil dilution system has not been used. The dilution system valve may be checked as follows: Remove the fuel line from the "Y" drain valve to the solenoid valve, and if a flow of gasoline exists when the fuel pressure is pumped up, replacement of the valve seat will be required.

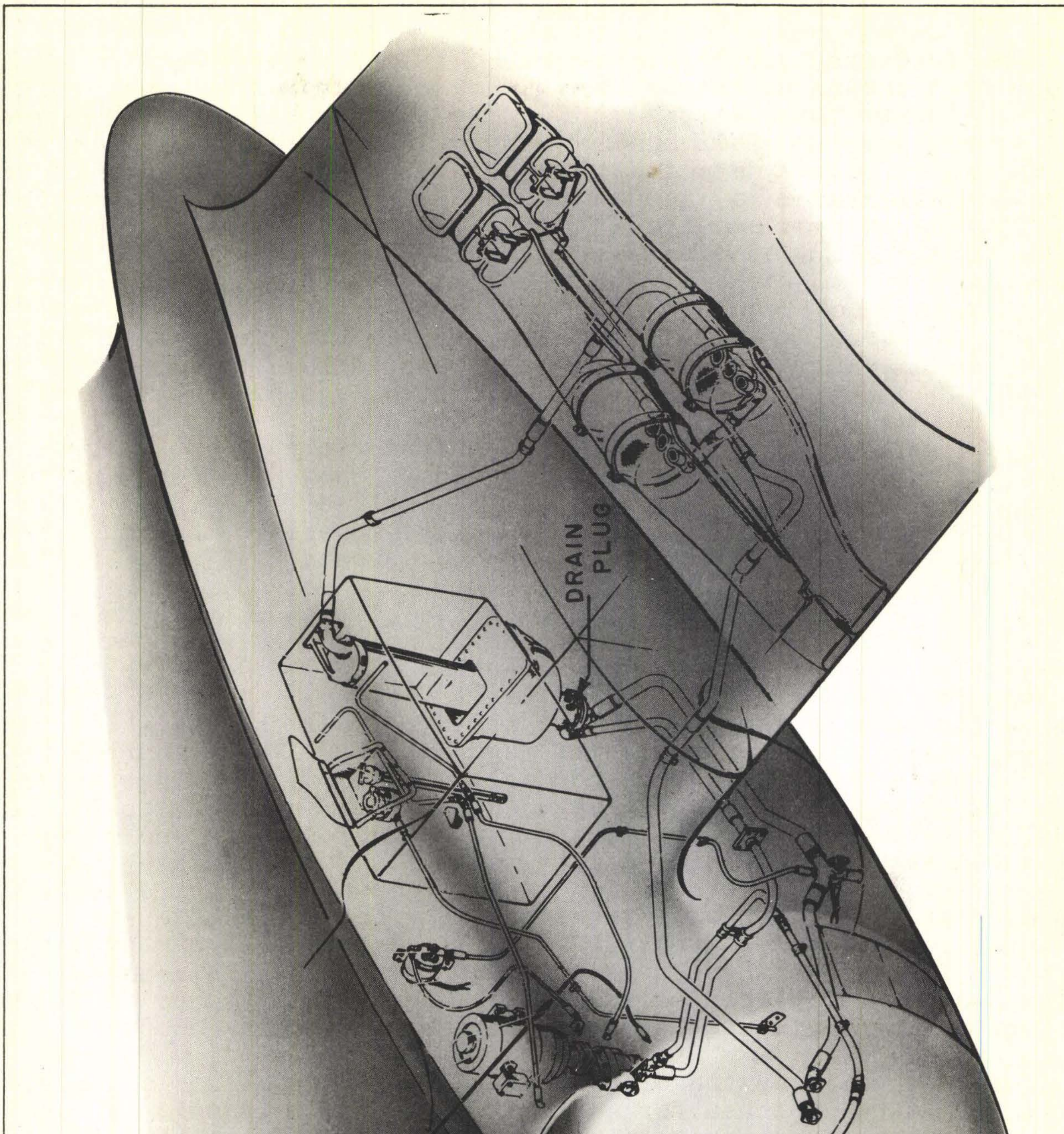


FIG. 9 OIL SYSTEM DIAGRAM

FIRE EXTINGUISHER

An Air Corps, type B-12, pressure fire extinguisher system, Fig. 10, has been installed to smother fires occurring in either engine nacelle. The system consists of a bottle storing carbon dioxide gas under a pressure from six hundred fifty (650) to two thousand six hundred (2600) pounds depending upon the air temperature, a means of releasing this charge by the pilot, and a length of perforated tubing installed in each nacelle. The carbon dioxide gas when released is thus dispersed throughout the nacelle, smothering the fire by blanketing it from the oxygen in the air. The carbon dioxide storage bottle is located on the right-hand side of the airplane, on the rear face of the bulkhead forming the front of the nose wheel well. The bottle is sealed by a valve which incorporates a safety disc, so designed that if the pressure in the bottle exceeds a safe limit, this disc blows off and allows the gas to escape. This will occur if bottle temperature reaches one hundred thirty (130) degrees; hence the necessity for location in a cool spot. In escaping the bottle, the gas passes through a short flexible line to the right side of the fuselage. The pressure of the gas breaks through a red celluloid sealing disc and is discharged overboard.

A line travels from the valve on the bottle up to a selector valve on the right side of the instrument panel accessible to the co-pilot. In the event of fire, the co-pilot may set the valve to direct the gas to either right or left-hand engine. Adjacent to the valve on the instrument panel is located a red pull handle which by means of a flexible cable to the storage bottle valve, discharges the bottle through the line. From the selector valve, two lines travel aft, along the side of the fuselage and across the front spar; one to each nacelle. At the nacelle the line turns forward and encircles the engine mount ring. Stub lines branch off to complete the encirclement of the carburetor. In order to flood the entire accessory compartment with gas, stub lines and ring in the nacelle are perforated. Although the Air Corps drawing of the type A-12 system shows a flexible connection where the line enters the nacelle, none is installed on this airplane because all tubing is attached to fixed structure and none vibrates with the engine.

Before the fire extinguisher carbon dioxide bottle is installed, it should be checked for a full charge by weighing. If the weight is more than four ounces under that stenciled on the side of the bottle, it must be rejected, and recharged to specified weight. After the bottle is installed, the status of its charge may be checked by observing the red pop-off disc on the right side of the fuselage. Inspection of this disc should be made prior to each flight. If found to be missing, the bottle should be removed and replaced with a fully charged bottle. Any system, which is not discharged within a six month period, should have its carbon dioxide bottle removed from the airplane and checked by weight. A bottle four ounces or more underweight should be replaced.

When replacing a bottle in the airplane it will probably be found that the nipple to which the safety pop-off line attaches, will be in a different position from that on the bottle just removed. The

bottle originally installed in the airplane will be found to have a ninety (90) degree elbow, either installed on the safety line nipple, or lashed to the neck of the bottle. This elbow should be kept with the airplane. If its use is not required to connect the safety line of the replacement bottle, it should be lashed to the neck of the bottle, as the next replacement may require its use.

Referring to the diagram again, it will be seen that the fire extinguisher lines follow the routing of the engine controls and are therefore, accessible through the same doors and cover plates.

In addition to the pressure system just described, there are provided for ground use two carbon tetrachloride hand fire extinguishers. One is carried inside each nacelle, on the lower outboard side just aft of the firewall. Access to these may be had by pressing the small red panel set flush with the nacelle skin. The red door immediately underneath will then open, revealing the extinguisher mounted on its inner face.

Other than the periodic inspection of the carbon dioxide bottle, there are no service or maintenance problems presented by this system.

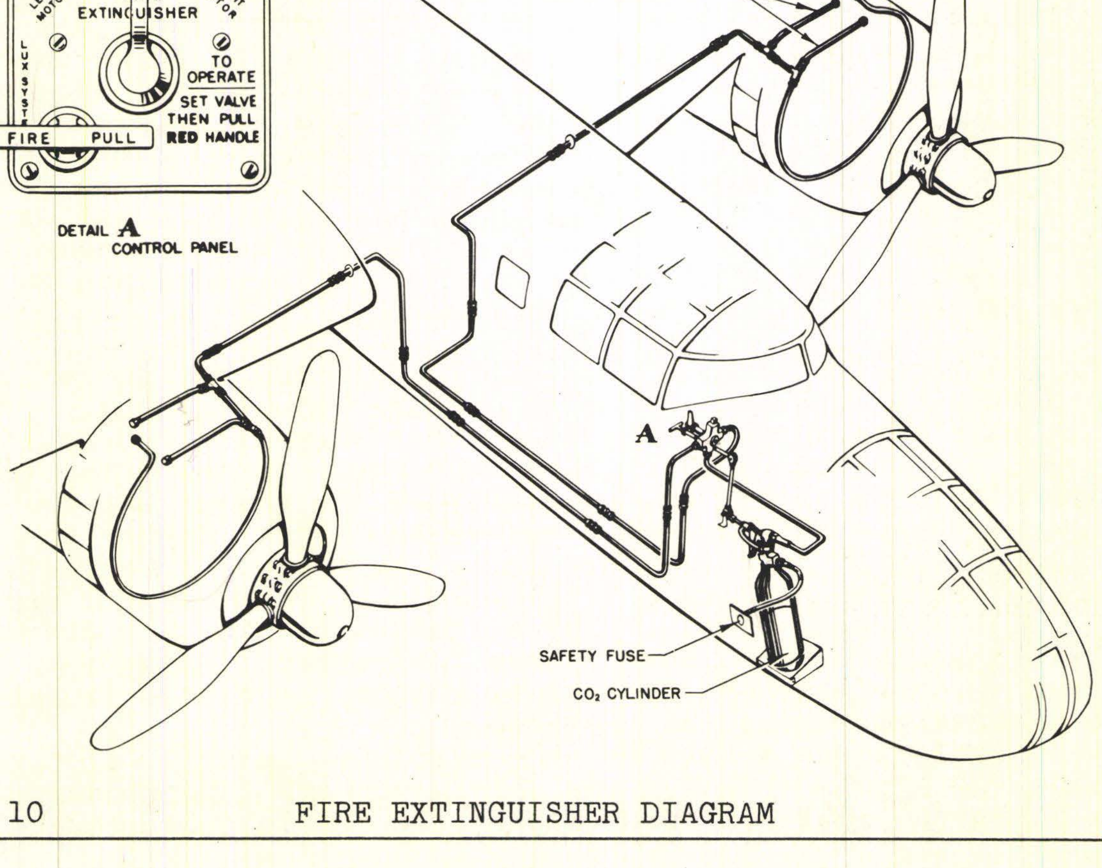


FIG. 10 FIRE EXTINGUISHER DIAGRAM

ADDENDUM I

Items peculiar to B-25, B-25A and B-25B airplanes only.

1. ENGINE

Power for the B-25, B-25A and B-25B is obtained from two Wright R-2600-9, 14 cylinder, twin-row, air cooled engines.

2. CARBURETOR

The carburetor used on B-25, B-25A and B-25B is a Stromberg injection type, which incorporates an automatic mixture control and an electric primer pump.

3. FUEL PUMP

The fuel pump pad on this installation is used to drive a Pesco, type 465, hydraulic generator on the first 24 airplanes only (B-25). This in turn, through a small independent hydraulic system, drives a hydraulic motor attached to a type G-9 fuel pump in the fuselage.

4. MISCELLANEOUS ENGINE ACCESSORIES

A type B-7 vacuum pump is used on the B-25, B-25A and B-25B airplanes only. The B-25 and B-25A airplanes only are fitted with two type E-7 - 50 ampere generators. On the B-25B model, a 12-volt 100-ampere generator has been provided in the right nacelle. In addition, a 200-ampere, 24-volt generator, type P-1, has been installed in the left nacelle to provide power for the electrically operated turrets.

A type H-2 starter is installed on both engines of the B-25, B-25A and B-25B airplanes. A single hand crank will be found stowed in the left nacelle, on the outboard side, just aft of the landing wheel strut.

5. ENGINE CONTROLS

The engine control system in the B-25, B-25A and B-25B is of the push-pull rod and bellcrank type instead of the cable system as on the B-25C.

6. OIL SYSTEM

To fill the oil storage compartment on the B-25 Airplane, open a Dzus fastened door on top of the nacelle, and unscrew the filler

cap located directly beneath on the front spar web in the nacelle over the front spar. It may be filled to a normal capacity of twenty-four and five tenths (24.5) gallons. To fill to the maximum capacity of forty-five (45) gallons, simply fill to overflowing at the filler cap adapter.

The filler cap on the B-25A and B-25B is located aft of the front spar, and is accessible through a Dzus fastened door in the nacelle fairing. A dipstick graduated in gallons is provided beside the filler cap. This must be consulted to determine when the compartment has been filled to normal and maximum levels. The maximum capacity on the B-25A and B-25B airplanes has been reduced to thirty-six (36) gallons, because of a reduction in fuel capacity.

FUEL SYSTEM

NORTH AMERICAN AVIATION Inc.

Fuel System LECTURE

B-25 SERIES AIRPLANES

PREPARED BY Paul J. Lansing

NOTE

THE INFORMATION CONTAINED IN THIS LECTURE WAS CORRECT AS OF MAY 15, 1942. REFER TO HANDBOOK OF OPERATION AND SERVICE INSTRUCTIONS FOR THE LATEST INFORMATION.

N A A

INGLEWOOD, CALIFORNIA

I N D E X

ILLUSTRATIONS

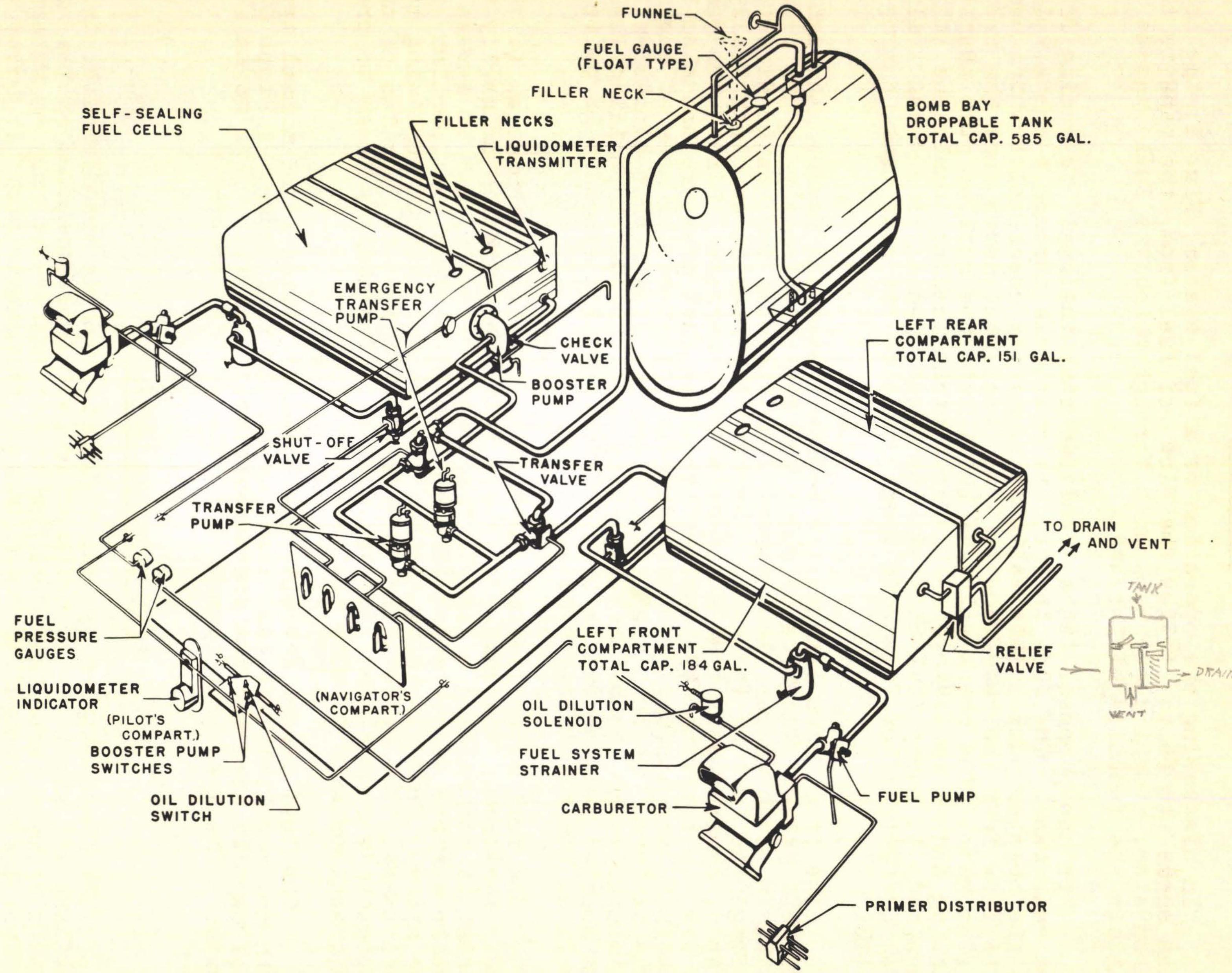


FIG. I FUEL SYSTEM DIAGRAM (B-25C)

OPERATION

In discussing the operation of a fuel system, Fig. 1, the best plan seems to be to follow the flow of fuel from the tank to the carburetor, stopping at each unit through which the fuel passes to explain the function of the unit.

For our purposes let's consider that the fuel is coming from the rear tank. The flow is from the rear tank through a check valve to the booster pump. This valve is a one-way check valve which permits flow from the rear tank to the front, but never from the front to the rear. The check valve is built into the booster pump adapter casting and is necessary, as under various loading conditions it is required to carry fuel only in the front tanks. The check valve also prevents flow from the front tank to the rear tank during a climb.

The fuel then leaves the booster pump and passes through a shut-off valve. The booster pumps are mounted directly on the front tank, in such manner that vapor from the pump is vented directly through the fuel in the tank. The booster pump is an electrically-driven, centrifugal type and serves two purposes. First, the pump is used in starting the engines to attain fuel pressure and also in take-off and landing to maintain fuel pressure in case of engine pump failure. Second, the pump is used in the higher altitudes to eliminate vapor locks that may tend to occur due to boiling fuel. The booster pump should be used only as required since it is quite a drain on the electrical system.

The fuel after leaving the shut-off valve continues on to the fuel strainer. The shut-off valve is in the circuit primarily to assist in controlling a fire in the engine nacelle, but it serves a double purpose as it makes it possible to work on that portion of the system from the valve to the carburetor without draining the fuel tanks. The valve dials are located in the aft portion of the navigator's compartment and are equipped with safety locks to prevent accidentally turning fuel supply off.

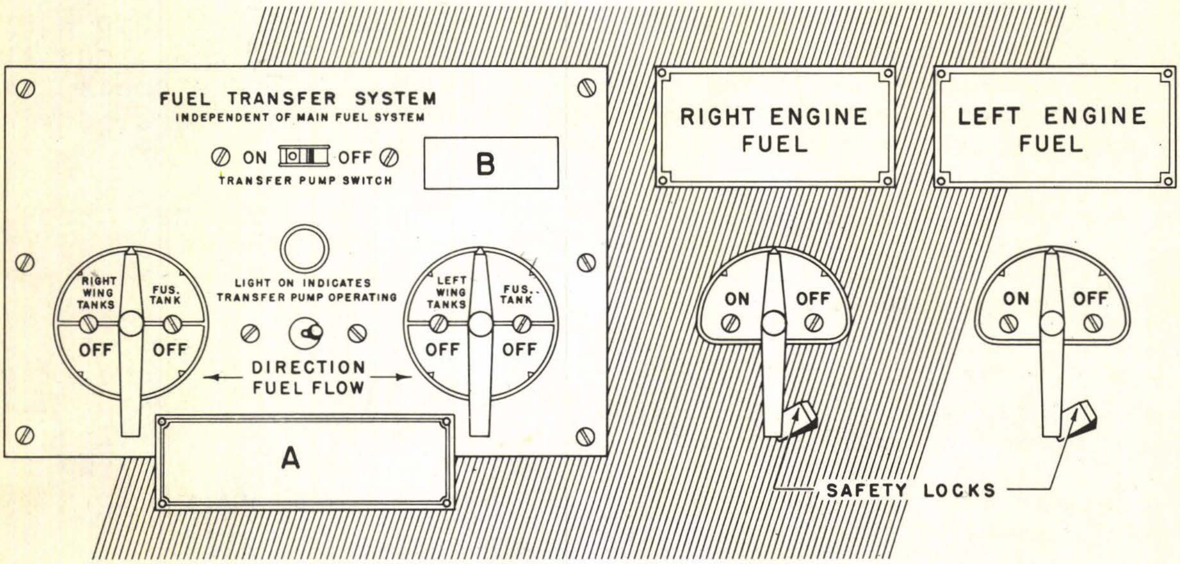
The fuel passes through the strainer, which is a normal type with no peculiarities, and then on to the fuel pump. A type G-9 fuel pump is used and the pressure is set from six (6) to seven (7) pounds. The fuel then passes on to the Holley Carburetor.

FUEL TRANSFER SYSTEM

The fuel transfer system, Fig.1, is used to transfer fuel from one tank to another. In conjunction with the transfer system it should be made clear that fuel for either engine can only be obtained from their respective fuel tanks. This means that in order to use the overload, or fuselage tank fuel, you will have to first transfer it to the wing tanks; also, if an engine fails to operate due to something in the engine itself,it will be necessary to transfer its fuel supply to the opposite tank before it can be used.

There is no cross feed system provided in this installation.

The fuel transfer controls are located on the right side in the rear of the navigator's compartment, Fig. 2, and consist of two (2) valves, (one marked "Right Wing Tanks" - "Fus. Tank" - "OFF" and the other "Left Wing Tanks" - "Fus. Tank" - "OFF") a switch, (marked "Transfer Pump Switch" - "ON" - "OFF") an indicator light and another switch (marked "Direction Fuel Flow").



INSTRUCTIONS **A**

1. CONNECT TANKS DESIRED AS SHOWN ON BOTH FUEL COCK DIALS.
2. SELECT DIRECTION OF FUEL FLOW WITH SWITCH.
3. FUEL IS DELIVERED TO FRONT WING TANK ONLY. FUEL IS TAKEN FROM BOTH FRONT AND REAR TANKS.
4. DO NOT OVERFLOW.
5. TRANSFER PUMP SWITCH WILL TRIP TO OFF IF VALVE IS SET IN CLOSED POSITION WHILE PUMP IS OPERATING.

INSTRUCTIONS **B**

FUSELAGE TANK CAPACITY
585 GALS.
LEVEL GAGE UNDER
DOOR OVER BOMB BAY

FIG. 2 FUEL TRANSFER CONTROLS (NAVIGATOR'S COMPARTMENT)

The transferring of fuel from one tank to another is accomplished as follows: First, connect the desired tanks by setting handles on both dials, then push direction switch in the direction you wish the fuel to flow. After doing this, turn fuel transfer switch to "ON". The indicator light will be on while fuel is being transferred.

A circuit breaker is incorporated in the transfer pump switch and will trip (signal light will go out) if a valve is set in "OFF" position while pump is operating; also if valve is set to "Fus. Tank" and tank is not installed. Should this happen, it is only necessary to correctly position the transfer valve or valves and/or fuel flow switch and again switch "ON" transfer pump motor switch. When transfer system is not in use make certain that transfer valves and transfer pump motor switches are "OFF".

BOMB BAY DROPPABLE TANK INSTALLATION

Prior to installing bomb bay droppable tank, open bomb bay doors by moving bombardier's control handle to "DOORS OPEN RACKS LOCKED" position. After checking to see that the two thousand (2000) pound bomb rack or bombs are not installed, move bomb release handle forward to "SALVO" position and then back to "SELECTIVE" position. This procedure will insure that the pilot's emergency release mechanism is cocked. Install two (2), Type A-2, bomb release units at stations three (3) and four (4) on bomb racks. With the bomb release handle at the "SELECTIVE" position, first cock the arm safe lever of the release unit and second the release lever. Check operation of pilot's EMERGENCY RELEASE before bomb bay tank terminal assemblies are installed.After re-cocking pilot's emergency release unit as explained above,the bomb bay tank, Fig.3, may be installed as follows: (The symbols in the following paragraphs all refer to Fig. 3.)

1. Bolt left and right upper supports (A), provided with felt padding, to bomb rails and attach supporting brackets (B) and tie rod (C). Ascertain that fuel line is installed on right support.

2. Remove plug from elbow in tee fitting (D) attached to rear transfer valve at forward end of bomb bay and clamp fuel line (E) installed on right support to elbow at (D).

3. Attach aft end of line to elbow assembly (F) at top of bomb bay.

4. Check installation of Type A-2 bomb release units (J) at stations three (3) and four (4). Set bomb release handle in bombardier's compartment to "SALVO" and then to "SELECTIVE" position. This procedure will insure that pilot's emergency release mechanism is cocked.

5. Install complete terminal assembly (H) at rear tank release mechanism (G).

6. Cock arm safe lever (F) in release unit (J) and then cock release lever (K).

7. Rear tank release mechanism (G) will automatically cock but a check should be made as per the attached instruction plate. Adjust one-eighth (1/8) inch holes in line when bomb release unit is in "SELECTIVE" position. Bombardier's control handle should now be set to "LOCK" position.

8. Attach two B-7 bomb shackles (L) to terminal assemblies (M) and (N).

9. Engage shackles (L) with shackle support hooks at Stations three (3) and four (4).

10. If not already installed, install complete lower support

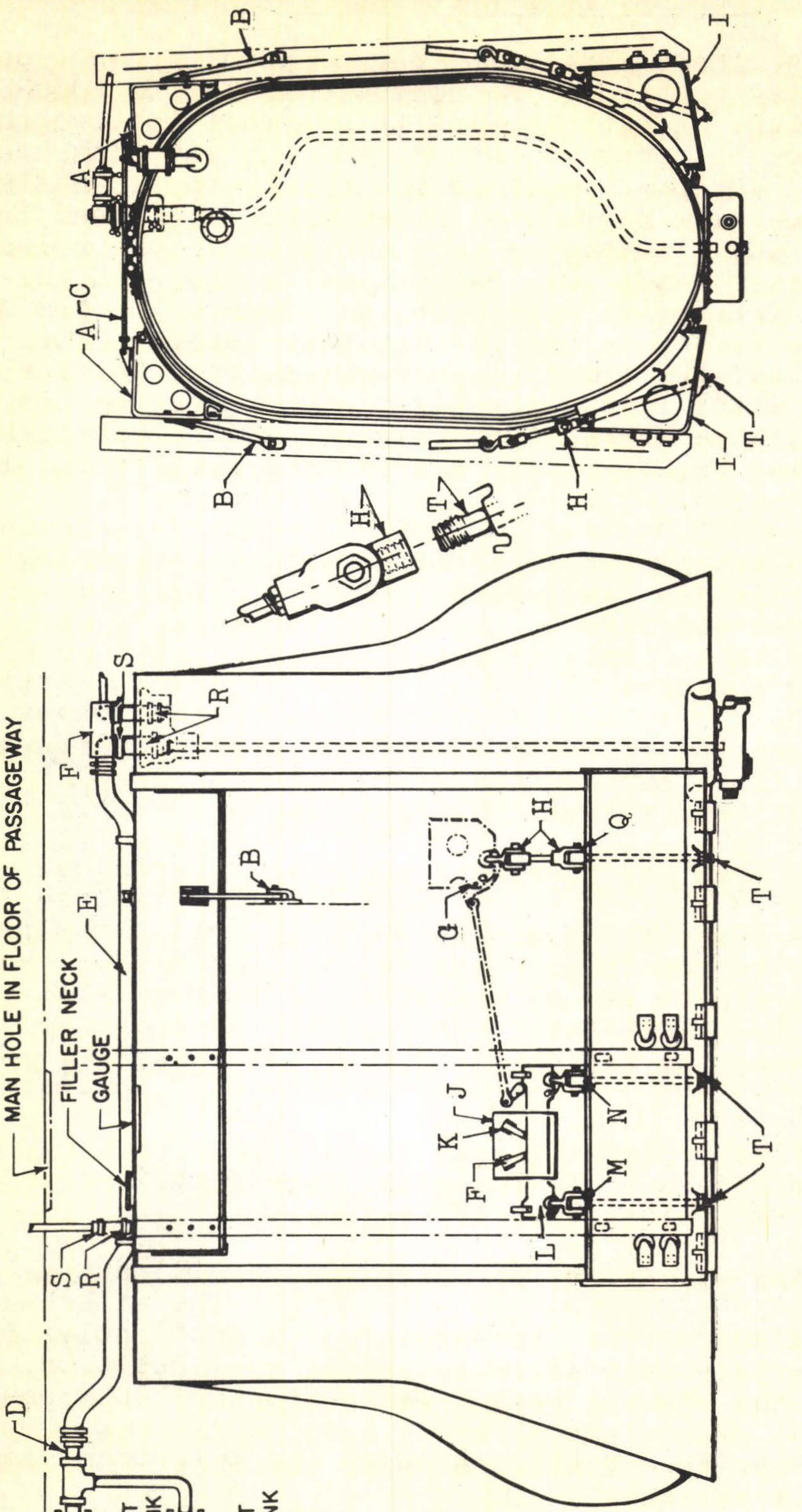


FIG. 3 BOMB BAY DROPPABLE TANK INSTALLATION (B-25C)

assemblies to tank and connect bonding braid as required.

11. Apply light grease to break-away joint nipples (R). Slip respective hoses over nipples on tank assembly and secure. Loosely install clamps (S) at other end of each hose.

12. Six men are required to install tank in place; five to hoist tank and one to start bolts in place. Lift tank into place, engaging roller guides along bomb rails and guiding break-away joint hoses around nipples. Insert six (6) attachment bolts through lower supports. Bolts should be turned into six (6) terminal assemblies at (M), (N) and (Q) on both lower support assemblies. To facilitate turning bolts into terminal assemblies, an additional nut should be screwed on the lower end of each bolt, both nuts locked together near end of bolt,using lower nut for turning bolt.

13. Turn attachment bolts on lower supports so that bolts screw in terminal assemblies. Remove lower nut after bolt is seated and take up evenly on remaining nuts to hold droppable tank firmly in place. Safety bolts at lower supports with lockwire.

14. Secure end of break-away joint hose connections by clamps (S) installed previously in No. 11. Finger tighten clamps about twenty-five (25) inch pounds.

BOMB BAY DROPPABLE FUEL TANK REMOVAL

Prior to removing bomb bay fuel tank, move bombardier's bomb control lever to the "DOORS OPEN RACKS LOCKED" position. Bomb bay door operating struts may be disconnected from door to provide additional space to facilitate the removal of the tank. After doors have been opened as described above, the tank may be removed as follows:

1. CAUTION: Check to make certain all fuel has been drained from the tank. In the event that auxiliary tanks have been carried, close shut-off valves leading to bomb bay tank.

2. Loosen clamps (S) at break-away joint nipples (R).

3. WARNING: Prior to releasing bomb bay droppable tank, ascertain that suitable padded supports capable of supporting the tank's weight (approximately two hundred sixty (260) pounds empty) are placed under the tank or at least six men are stationed under the tank to lower tank after it is released.

4. The tank should then be released by moving the bombardier's bomb control handle forward to the "SALVO" position. The pilot's emergency bomb release control may be used ONLY if control lever in bombardier's compartment is inaccessible.

Carefully lower tank to prevent it from becoming damaged, guiding rear terminal assemblies (H) clear of fuselage.

5. Slide bottom of tank towards bomb bay door with disconnected strut. This door held in fully opened position will allow tank to clear opening and lay on its side. Then slide tank forward from beneath bomb bay.
6. Remove bomb shackles (L) from bomb rack at each side of bomb bay.
7. Loosen clamps securing fuel hose (E) from elbow assembly (F) and tee fitting elbow (D) at rear of fuel transfer valve. Disconnect hose ends from the fittings.
8. Install a plug at elbow in tee fitting at D. It is IMPORTANT to make sure the plug is installed. Allow fuel hose (E) to remain with the upper supports (A) and allow elbow assembly (F) to remain with the airplane.
9. Remove tie rod (C) interconnecting both upper supports (A) and brackets (B), then remove upper supports.
10. Connect detached operating struts to bomb bay door and close doors by hydraulic hand pump.

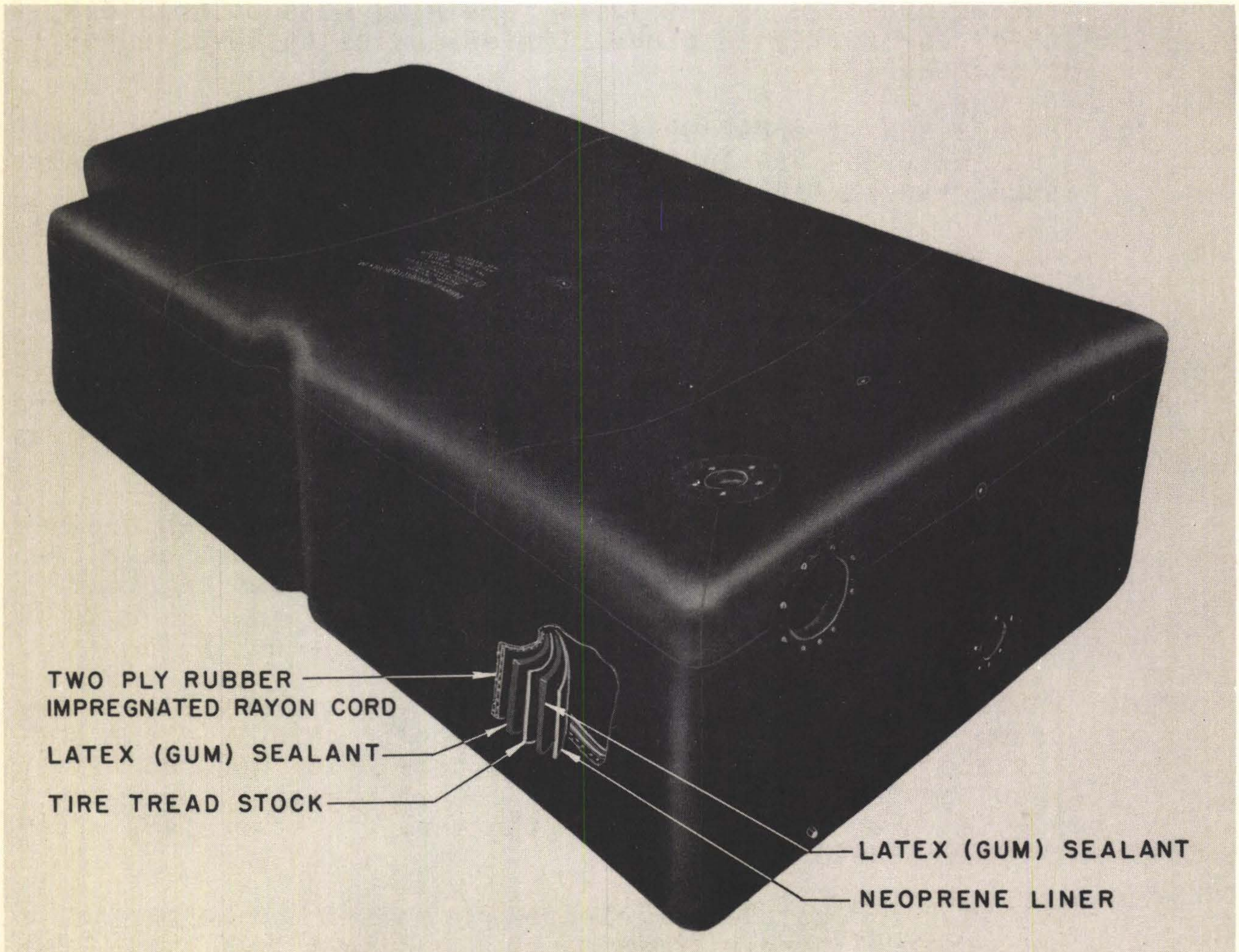


FIG. 4

FUEL CELLS

The wing tanks on these airplanes are accessible by removing tank doors which expose the complete cell. These cells are of the self-sealing type, Fig. 4, and are attached to surfaces of the wing to prevent bags from collapsing or shifting due to their weight. The fuel cells are vented through a check relief valve in the engine nacelle. The system incorporates a vent and drain line. The valve is so arranged in the line that overflow fuel is prevented from running back down the vent line by a check valve but must build up a pressure equal to fourteen (14) inches of water to open the relief valve. This allows fuel to drain and prevents excessive pressurizing of the tanks.

PRIMER

An electrically operated priming system is provided for each engine. The electric primers are actuated by a type B-11 switch located on the pedestal switch box adjacent to the starter switches. A primer solenoid is located on each carburetor and when the fuel system is pressurized by the booster pumps and the solenoid is energized, fuel is admitted through the primer distributor tubes to certain cylinder intake ports.

CARBURETOR

The carburetor used on this airplane is the Holley Aircraft Engine Carburetor - Model 1685H. This carburetor has a single air passage into which fuel is supplied from a single fuel supply chamber. Fuel is induced into the air passage by a controlled pressure differential produced by a reduction in the cross-sectional area of the air passage opening. The carburetor is unlike those of other designs in that the supply chamber float mechanism is replaced by a diaphragm mechanism and the control of the air passage is accomplished by means of a variable venturi rather than by the conventional butterfly valve and fixed venturi. The fuel discharge nozzle and venturi throttles are arranged in such a way that the carburetor is inherently free of ordinary icing troubles.

This carburetor has incorporated in it a stabilizer valve to provide automatic altitude,temperature and engine load compensation; a built-in vapor separator which removes any air or vapor from the gasoline before it reaches the metering orifice; a power mixture valve which makes it impossible for the pilot to use cruising lean mixtures at high power output, which might cause serious damage to the engine.

MAIN BODY CONSTRUCTION

The main body of the carburetor, Fig. 5, consists of two (2) end blocks bolted between two (2) side plates. The two (2) modified cylindrical throttles, the metering channel,the discharge nozzle and

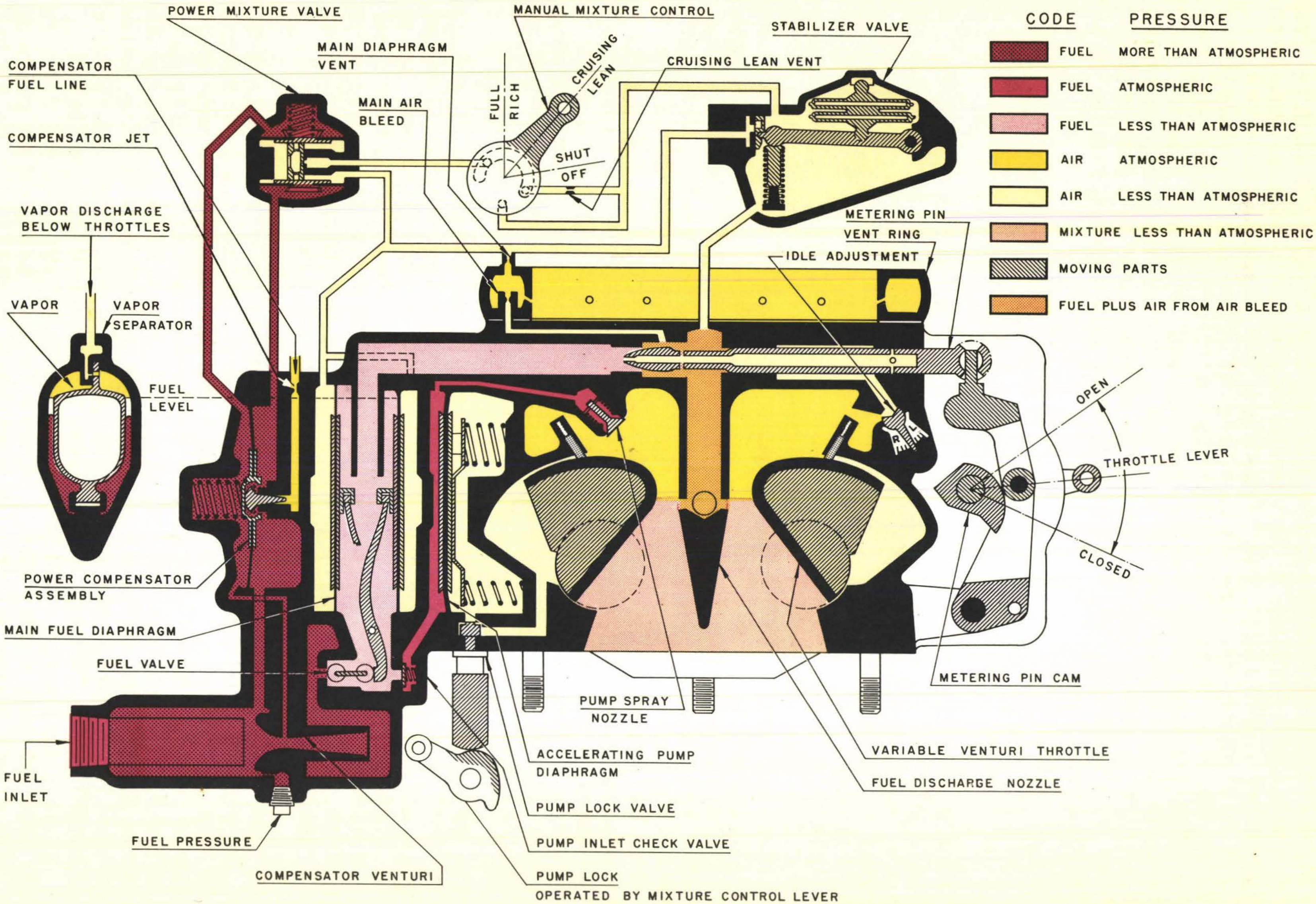
the throttle shaft are assembled with the main body. The throttles are modified cylindrical sectors having the discharge nozzle located between them and forming a streamlined venturi-shaped passage for all degrees of opening. The throttles fit in the main body with a small end clearance and are sealed against leakage by means of plastic molded brushes which bear lightly on the top of each cylindrical sector. The brushes are spring-loaded and provide a more positive seal over an indefinite period of time. A gear on each throttle and on the throttle lever shaft serves to drive them in synchronism. The throttles are mounted on roller bearings and the throttle shaft on ball bearings.

OPERATION

In tracing the flow of fuel through the carburetor, Fig. 5, we will begin at the fuel inlet located on the left side of the carburetor as we face the data plate. Fuel under pressure from the fuel pump enters the inlet at a pressure of six (6) to seven (7) pounds, passes through the compensator venturi, opens the fuel valve and enters the diaphragm chamber between two (2) diaphragms. As the chamber fills the weight of the fuel causes the diaphragm to bulge out and forcing the ball ended plunger valves attached to the ends of the diaphragm support arms to close. At a certain height the weight of the fuel in the chamber would exert sufficient force on the diaphragms to close the fuel valves in the carburetor against the fuel pressure, however, at the top of the chamber is an outlet leading to the metering channel and suction from the fuel discharge nozzle is carried back to the outlet of the chamber and tends to draw the diaphragms together and thus open the fuel valves to admit more fuel. At all times when the engine is running the diaphragm chamber is entirely filled with fuel thus assuring uninterrupted flow to the metering channel.

The regulation of fuel air ratio is obtained by the tapered metering needle and a restriction in the metering channel.The metering needle is actuated by means of a cam lever attached to shaft which in turn is geared to the throttles. When the throttles are opened to admit more air, the fuel passage opening is correspondingly increased to admit more fuel through the metering channel and provide the proper fuel flow at the discharge nozzle.

In the event that added power is required to attain maximum output, an enriched mixture may be obtained by the power compensator built in the carburetor. The compensator is automatic and operates in conjunction with the difference in pressure at the entrance and throat of the venturi located at the fuel inlet line.A spring-loaded compensator diaphragm and needle valve is unseated when the pressure is large enough to overcome the spring. Fuel is then admitted from the fuel inlet line through the valve into the compensator line and then on to the discharge nozzle through the external tube located on the rear side of the carburetor. There is no mechanical connection between the power compensator and throttle mechanism. Above a certain power output normally supplied by the main metering channel,



CODE		PRESSURE
	FUEL	MORE THAN ATMOSPHERIC
	FUEL	ATMOSPHERIC
	FUEL	LESS THAN ATMOSPHERIC
	AIR	ATMOSPHERIC
	AIR	LESS THAN ATMOSPHERIC
	MIXTURE	LESS THAN ATMOSPHERIC
	MOVING PARTS	
	FUEL PLUS AIR FROM AIR BLEED	

FIG. 5 HOLLEY CARBURETOR DIAGRAM

the mixture is enriched regardless of throttle opening or altitude.

An accelerating pump diaphragm has been provided to enable rapid and positive acceleration of the engine. The pump mechanism is located between the main diaphragm mechanism and the body of the carburetor. The mechanism consists essentially of an inlet valve at the bottom of the main diaphragm chamber, a spring-loaded diaphragm, an outlet spray nozzle directing the accelerating charge down into the air passage of the carburetor and the pump lock valve. The latter is operated by the mixture control lever. When the engine is idling the high vacuum below the throttles pulls the diaphragm against the springs and allows fuel to enter the pump chamber through the inlet check valve. When the throttles are opened the vacuum is broken and the spring tension forces the diaphragm back and compresses the fuel in the pump chamber out through the spray nozzle. The accelerating pump lock valve is in the passage leading to the vacuum side of the diaphragm and is closed when the mixture control lever is moved to the idle cut-off position. This valve is provided to prevent the pump from operating when the engine is being stopped.

A manual mixture control is also provided on the carburetor and three (3) positions are shown in the diagram; Full Rich, Cruising Lean and Idle Cut-Off.

IN THE EVENT THAT THE CARBURETOR SHOULD BECOME INOPERATIVE IT WILL BE NECESSARY TO REMOVE IT AND SEND IT TO A STATION EQUIPPED FOR ADJUSTING AND FLOW TESTING, BEFORE INSTALLATION FOLLOWING REWORK.

FUEL GAGE FLOAT POSITION DIAGRAMS

The fuel gage float position diagrams, Fig. 6 to 16,inclusive, illustrates the fuel levels and float positions at various fuel loadings during dive, climb and level flight conditions. As will be noted, the fuel level indicator in the pilot's compartment is accurate in level flight position only. The readings of the fuel indicator are entirely dependent upon the floats shown on the series of diagrams.

In brief summary, the front and rear self-sealing fuel compartments are interconnected by means of a line extending from the rear compartment to the booster pump adapter on the front compartment. The booster pump is provided with a check valve at the line connection which permits fuel to flow from the rear compartment to the front compartment and to the engine but does not permit fuel to flow to the rear compartment. This provides the desired condition of having the major portion of the fuel loads forward.

FUEL LEVELS AND FLOAT POSITION DIAGRAMS

Before Take-Off - Full Load:

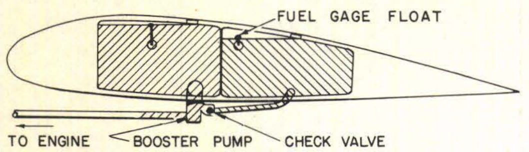


FIG. 6

The fuel compartments are full and the fuel is at a level even with the filler necks with required expansion space remaining. The fuel level of the front compartment being higher, the pressure head of the fuel is greater, thus closing the check valve and permitting feed to engine from front compartment only. With airplane in level attitude, fuel gages give accurate readings.

Twenty (20) Degree Climb - Full Load:

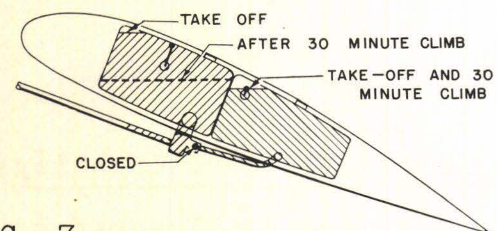


FIG. 7

In a climb the pressure head of fuel is still greater in front compartment even after thirty minutes, thus the check valve remains closed and fuel is fed to the engine from the front compartment only until fuel levels become equal. Then fuel is fed to the engine from both compartments.

Level Flight - Moment After Thirty (30) Minute Climb:

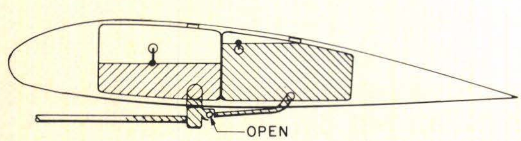


FIG. 8

The fuel head is greater in the rear compartment, and, therefore, the check valve is open and fuel is fed to the engine from the rear compartment only. The fuel levels in this condition have only a very slight tendency to equalize by means of fuel from the rear compartment draining into the front compartment. When the levels become equalized, mainly by means of consuming fuel from the rear compartment, the engine will be fed equally from both compartments. Fuel indicator readings are accurate.

Level Flight - One-Half (1/2) Fuel Capacity:

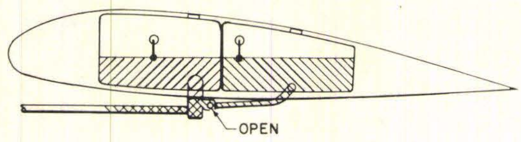


FIG. 9

If no dives are executed the fuel levels will have a tendency to remain equalized as fuel is consumed. Fuel indicator readings are accurate.

Twenty (20) Degree Climb - One-Half (1/2) Fuel Capacity:

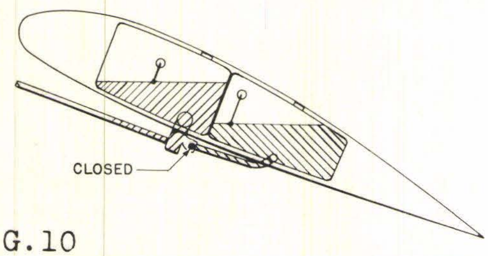


FIG.10

With the same amount of fuel in each tank as in Fig. 9, it is clearly illustrated in Fig. 10 that the fuel gage floats acquire a different position and thus fuel level readings should only be taken in level flight.

Prolonged Sixteen (16) Degree Dive - One-Half (1/2) Fuel Capacity:

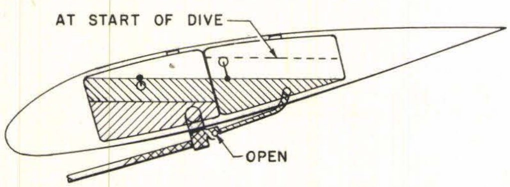


FIG.11

Levels are illustrated in Fig. 11 at start of dive and their tendency to equalize during prolonged diving. Fuel is fed to engine from rear compartment only until levels become equalized. Cross-hatching illustrates amount of fuel automatically shifted forward.

Before Take-Off - Normal Load:

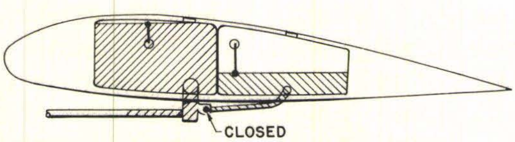


FIG.12

Accurate fuel gage readings are again shown in Fig. 12.

Twenty (20) Degree Climb - Normal Load:

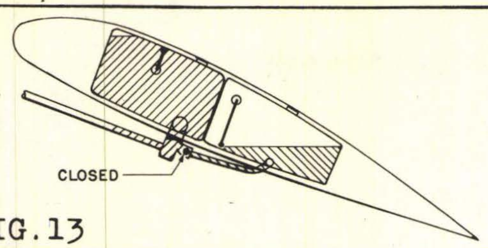


FIG.13

Compartments have the same fuel content as in Fig.12, but gage readings have been affected by the climb as shown in Fig. 13.

Sixteen (16) Degree Dive - Normal Load:

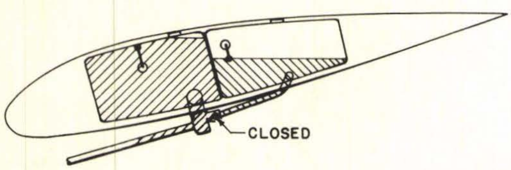


FIG.14

Fig. 14 illustrates a sixteen (16) degree dive and if the fuel level in the front compartment is higher than that of the rear, the check valve remains closed and fuel is fed to the engine from the front compartment only until levels have equalized.

Fuel Transferred from Bomb Tank - Level Flight:

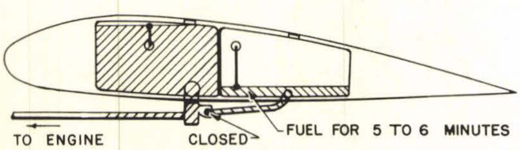


FIG.15

Fuel can be transferred from the bomb bay tank to the front compartment only. Since no low level signal will automatically warn the pilot when a compartment reaches low level, sight readings on the pilot's liquidometer indicator must be taken at intervals to eliminate the possibility of running dry before transfer of fuel. The lowest reading shown on the liquidometer indicator is ten (10) gallons.

Level Flight - Minimum Cruising Condition:

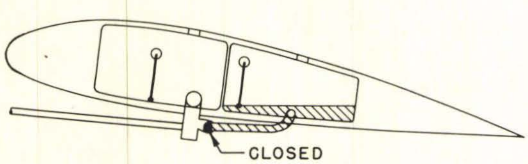


FIG.16

A special case exists, shown in Fig. 16, that inasmuch as the angle of attack of the airplane, while maintaining level flight, may vary to as much as six (6) degrees, which is the attitude of the airplane at minimum cruising condition; approximately 45 gallons of fuel will remain in rear compartment for engine consumption when the front compartment is empty. This fuel will feed to the engine and will be consumed at a rate dependent upon power being used at the time.

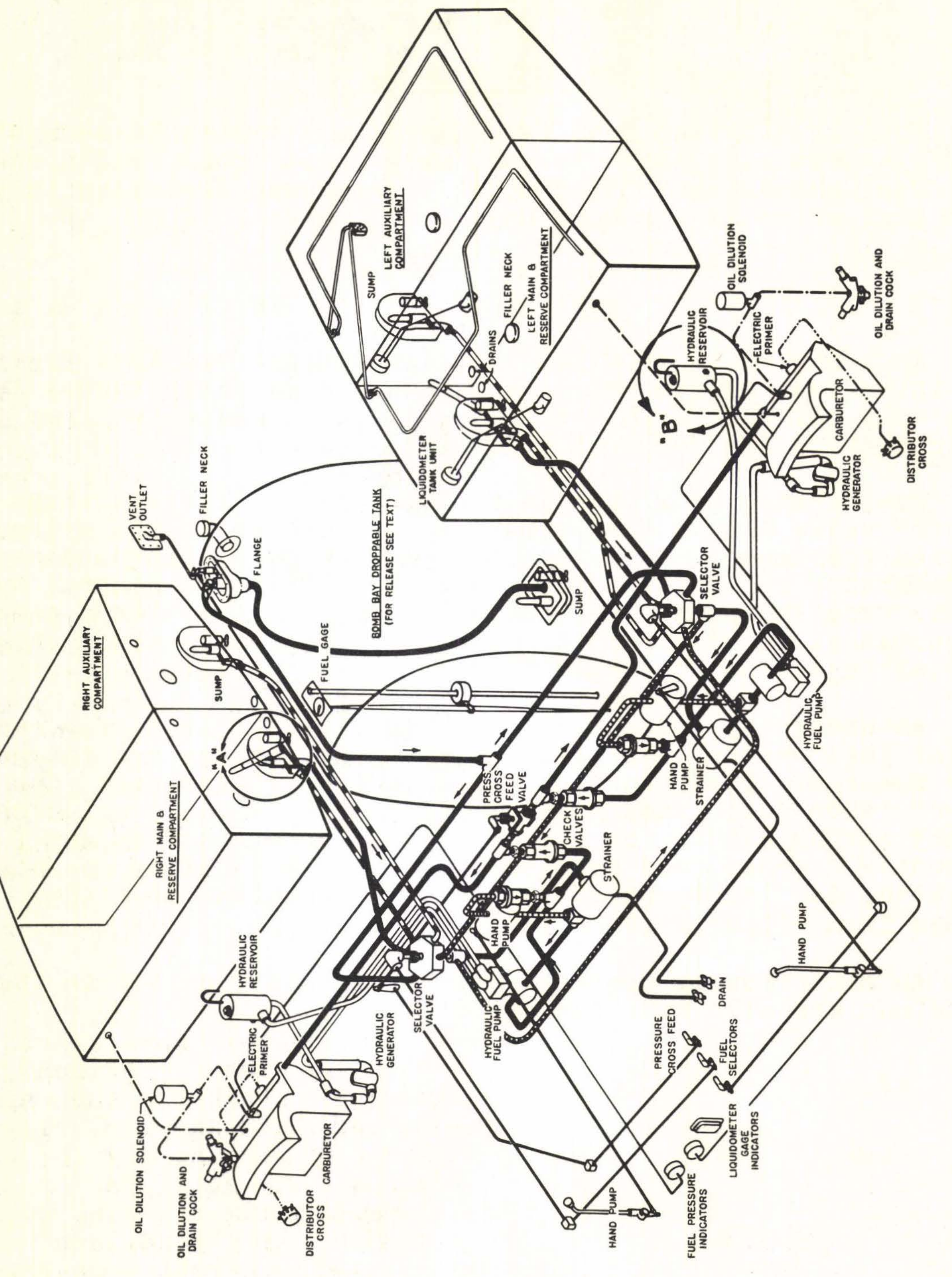


FIG. 17 FUEL SYSTEM DIAGRAM (B-25)

ADDENDUM I

Items peculiar to B-25 Airplanes only.

1. FUEL STORAGE

Fuel is supplied from two fuel compartments in each wing consisting essentially of a forward main compartment and a rear auxiliary fuel compartment. A droppable overload fuel tank is provided for installation in the bomb bay.

2. GENERAL OPERATION

Each engine is provided with an independent fuel system, Fig. 17. This fuel system was installed on the first twenty-four (24) ships only of the B-25. Briefly, the path of flow from the main compartment to the carburetor is as follows:

Fuel coming from the main compartment flows through a fuel selector valve into a fuel strainer and thence to the hydraulically operated fuel pump. This pump is operated by an independent hydraulic generator and is separate from the airplane's general hydraulic system. From the pump, fuel passes through a line with a check valve incorporated in it direct to the Stromberg carburetor which is of the fuel injection type and incorporates the idle cut-off device.

An emergency hand fuel pump is also supplied for each independent fuel system. The independent fuel systems are interconnected by means of cross suction lines which interconnect the suction side of each fuel pump through the opposite fuel selector valve, thereby making either or both engines operative from any fuel compartment. A cross feed pressure line with a manually operated shut-off valve, is incorporated to permit operation of either or both engines from either or both fuel pumps.

An electrically operated primer is also provided in the system. Provisions are also made for oil dilution.

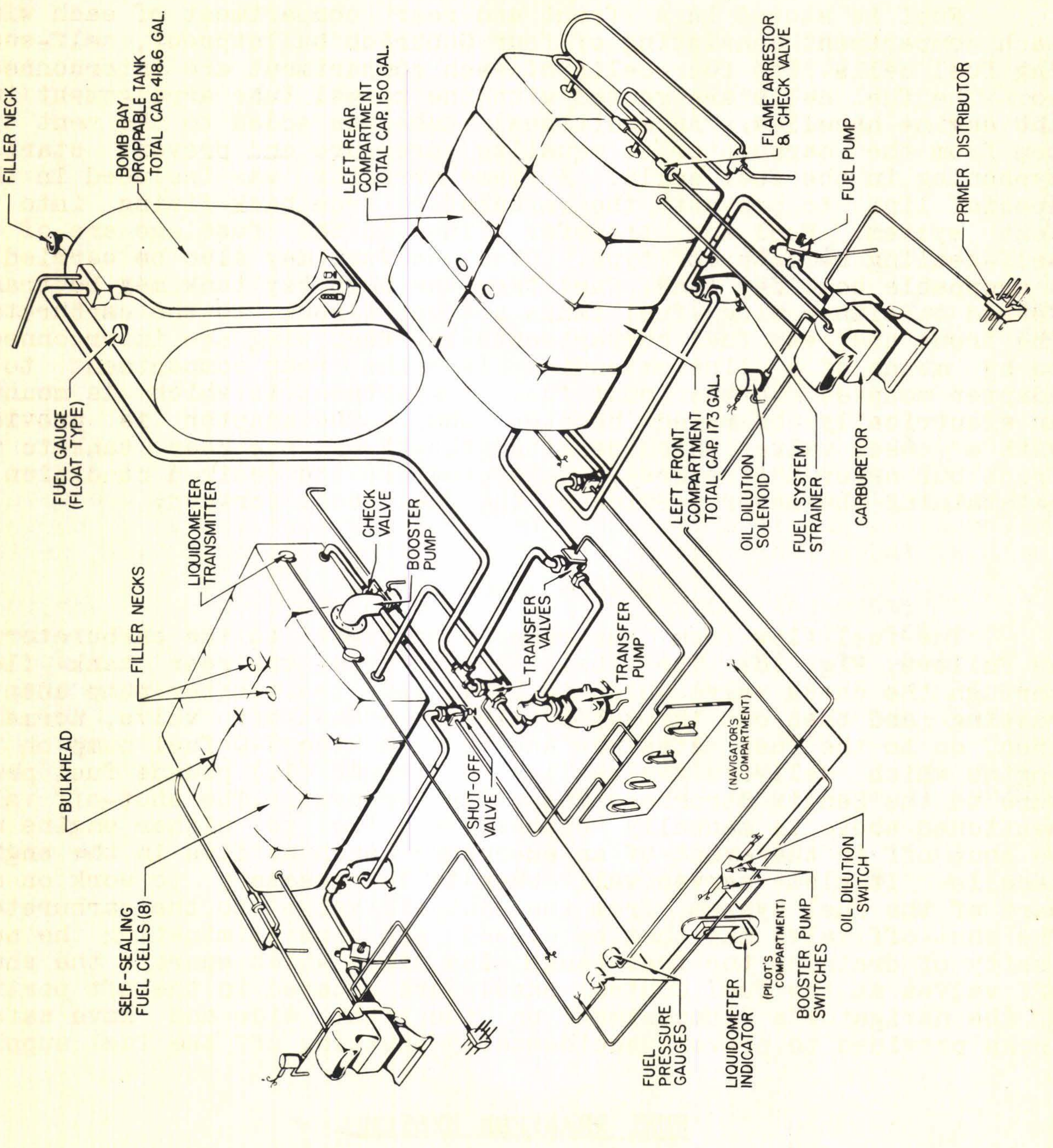


FIG. 18 FUEL SYSTEM DIAGRAM (B-25A AND B-25B)

ADDENDUM II

Items peculiar to B-25A and B-25B Airplanes.

1. FUEL STORAGE

Fuel is stored in a front and rear compartment of each wing; each compartment consisting of four Goodrich bulletproof, self-sealing fuel cells. The four cells of each compartment are interconnected. The fuel cells are vented with the normal tube arrangement into the engine nacelles. An additional tube was added to the vent system from the carburetor to equalize pressure and prevent start of syphoning in the fuel cells. A flame arrestor was included in this special line to prevent the carburetor from back-firing into the vent system. Fuel and transfer lines in the fuselage are of the self-sealing bulletproof type. Overload fuel may also be carried in a droppable bomb bay tank. Fuel from the bomb bay tank may be transferred to either wing fuel tanks but not direct to the carburetor. The front and rear fuel compartments in each wing are interconnected by means of a line extending from the rear compartment to an adapter mounted on the front fuel compartment to which is mounted an electrically operated booster pump. The adapter is provided with a check valve which permits flow from the rear tank to the front but never the reverse. This provides the desired condition of maintaining the major portion of the fuel loads forward.

2. GENERAL OPERATION

The fuel flow from the rear compartment to the carburetor is as follows, Fig. 18: The fuel flowing from the rear tank flows through the check valve which is built into the booster pump adapter casting and then on through a line to a shut-off valve, normally open, on to the fuel strainer and then to the G-9 fuel pump on the engine which delivers twelve (12) to sixteen (16) pounds fuel pressure to the Bendix Stromberg Injection Carburetor.The shut-off valve mentioned above is manually operated and fuel to either engine may be shut off in the event of an emergency such as fire in the engine nacelle. It also serves well when it is necessary to work on any part of the fuel system from the shut-off valve to the carburetor. The shut-off valve may then be closed and thus eliminating the necessity of draining the fuel tanks. The dials which operate the shut-off valves at the fuel control panel are located in the aft portion of the navigator's compartment on the right side and have safety locks provided to prevent accidentally shutting off the fuel supply.

3. FUEL TRANSFER SYSTEM

The fuel transfer system has been described in the B-25C system and is essentially the same in operation. The controls, Fig. 2, are located on the right side in the rear of the navigator's compartment adjacent to the shut-off valve dials.

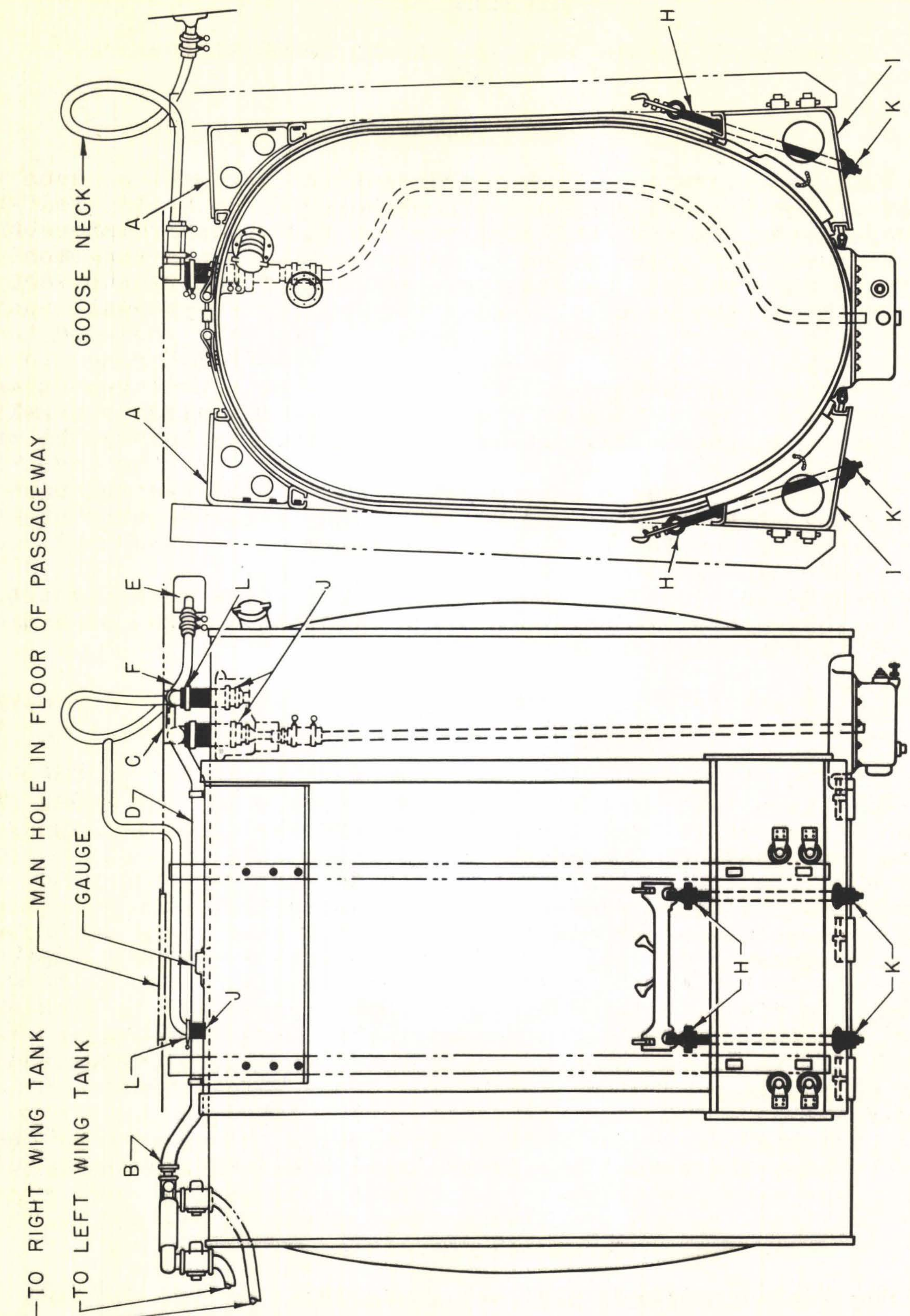


FIG. 19 BOMB BAY DROPPABLE TANK INSTALLATION (B-25, B-25A AND B-25B)

ADDENDUM III

Items peculiar to B-25, B-25A and B-25B Airplanes.

BOMB BAY DROPPABLE FUEL TANK INSTALLATION

Prior to installing bomb bay droppable tank move bomb bay door control - bomb release handle in bombardier's compartment to "DOORS OPEN" position. After checking to see that two thousand (2000) pound bomb rack or bombs are not installed, move arm safe handle to "SAFE" and bomb release handle first to "SALVO" and then to "SELECTIVE". This procedure will insure that pilot's emergency release mechanism is cocked.

After accomplishing the general instructions in the foregoing paragraph, the bomb bay tank, Fig. 19, may be installed as follows: (The symbols in the following paragraphs all refer to Fig. 19.)

1. Bolt left and right upper supports (A), provided with felt padding, to the upper end of their respective bomb rack rails through bolt holes provided.

2. Remove plug from elbow (B) at fuel valve assembly tee fitting located at upper right forward corner of bomb bay. Replace with hose elbow.

3. Attach elbow assembly (C) to under side of passageway floor through holes provided. Ascertain that there is no beading on lower elbow nipples.

4. Clamp fuel hose (D) to elbow assembly (C) and elbow (B) on fuel valve tee with clamps. Secure hose to upper tank supports with clamps.

5. Remove plug from vent fitting (E) located in upper right rear corner of bomb bay and clamp vent line (F) to elbow assembly (C) and vent fitting (E) with clamps.

6. Pull down firmly on bomb rack charger handle (G) located just forward of left bomb rack, cock the release levers at bomb stations three (3) and four (4), and then release the charger handle.

7. Attach two (2) terminal assemblies (H) to each of two (2) bomb shackles. Engage shackles with shackle support hooks at stations three (3) and four (4), making sure that release levers of shackle are properly engaged with bomb rack release levers.

8. Install lower support assemblies (I) on left and right sides of bomb bay tank with the seven (7) strap assemblies provided with felt padding. Connect bonding braids as required.

9. Apply light grease to tank nipples, slip hoses over nipples (J) and securely tighten one clamp on each hose. Loosely install an additional clamp to hold upper end of hoses after tank is installed.

10. By means of two persons at each end of droppable tank assembly and one at man hole above bomb bay, lift tank assembly into place in bomb bay engaging support roller guides with bomb rails and guiding fuel and vent line nipples into mating hoses on tanks.

11. Insert four (4) bolts, the stop nut and washers (K) through the lower tank supports and screw them into terminal assemblies hanging from bomb shackles until bolts bottom in terminals. To facilitate turning bolts into terminal assemblies, it is recommended that an additional nut be screwed on end of bolt, both nuts locked together near end of bolt, and the lower nut used to turn the bolt. Remove lower nut after bolt is seated and evenly take up stop nuts to hold droppable tank assembly firmly in place.

12. Safety four (4) bolts to lower support with lockwire.

13. Secure upper end of fuel and vent line hose connections secured to tank nipples, by means of clamps previously installed (L).

    NOTE: Tighten these clamps (L) just finger tight.

NOTE: Bomb bay doors should then be closed by means of hydraulic hand pump.

BOMB BAY DROPPABLE FUEL TANK REMOVAL

Prior to removing the bomb bay fuel tank, move bombardier's bomb control lever to the "DOORS OPEN RACKS LOCKED" position. After doors have been opened as described above, the tank may be removed as follows:

1. CAUTION: Check to make certain that all fuel has been drained from the tank.

2. Loosen clamps (L) on the upper end of fuel and vent line hose connections located on the top of the tank.

3. WARNING: Prior to releasing bomb bay droppable tank, ascertain that suitable padded supports, capable of supporting the tank's weight (approximately two hundred fifteen (215) pounds empty) are placed under the tank or at least four men are stationed at the ends of the tank to lower tank after it is released.

4. The tank should then be released by moving the bombardier's

bomb control handle on to "SALVO" position. Do not use any other control to release the tank. Carefully lower tank to prevent it from becoming damaged.

5. Remove bomb shackle from bomb rack at each side of bomb bay by pushing outboard on spring-loaded retainer lever on the shackle support hooks and lifting shackle free.

6. Loosen clamps (L) securing fuel hose to elbow at upper right forward corner of bomb bay and to elbow assembly (C) at center of bomb bay overhead and disconnect the hose ends from the fittings. Remove the elbow, to which the forward end of the hose was attached, from the "tee" fitting and install a suitable plug in the "tee" fitting. It is IMPORTANT to make sure the plug is installed.

7. Allow the fuel hose to remain with the upper right tank support and remove both upper supports by removing the attaching bolts.

NOTE: Allow elbow assembly and fuel vent line to remain with the airplane. Bomb bay doors may then be closed by using hand hydraulic pump.

ADDENDUM IV

Items peculiar to B-25, B-25A and B-25B Airplanes.

1. CARBURETOR

This discussion of the carburetor is not intended as a service instruction.

The carburetor used on these airplanes is a Bendix Stromberg metering injection non-icing type, known as P.D. 13E2. It is a three-barrel carburetor, employing venturi control of the metering system with an additional compensator for automatic air fuel ratio mixture control for altitude.

The pressure drop through the boost venturi acts through the diaphragms in A and B chamber to open the poppet valve between the unmetered fuel chamber and the fuel under pump pressure inlet chamber. The total pressure on the carburetor deck, measured by the impact tubes, acts to assist in this function. When the valve, actuated by the manual mixture control, is manually placed in the closed position which is automatic rich or lean, the impact pressure is controlled by the automatic mixture control unit. The balance and unbalance of pressure thus created, and acting on the air diaphragm, is reacted upon by the fuel pressure on the fuel diaphragm. The result is a mechanical action which is a constant opening of the poppet valve, to a greater or lesser degree, as the air flow in the throttle body requires. This then results in metering fuel by air flow.

The flow of air in the throttle body is controlled by the butterfly valves. The fuel thus metered is not in a state of constant flow and so is passed through control jets into another chamber. The fuel thus totally metered is under constant flow in the metered fuel chamber. The fuel is led from this chamber to the spray nozzles, located between the induction system of the engine and the butterfly valves of the carburetor.

The control jet system incorporates the idle control needle which controls fuel flowing into the metered fuel chamber of idling throttle positions. The manual mixture control needle is also located in this jet system and permits fuel to be shut off from the metered fuel chamber, thus causing a shut-off of the engine or idle cut-off. The fuel under pump pressure inlet chamber contains a float needle valve and permits some vapor to be bled out of the carburetor inlet.

The economizer valve is also controlled by diaphragms acted upon by the venturi suction and the impact tube pressure.

The accelerating pump is integrally connected to the nozzle system and is actuated by pressure drop as shown. This carburetor when properly installed, will meter closely and has economical per-

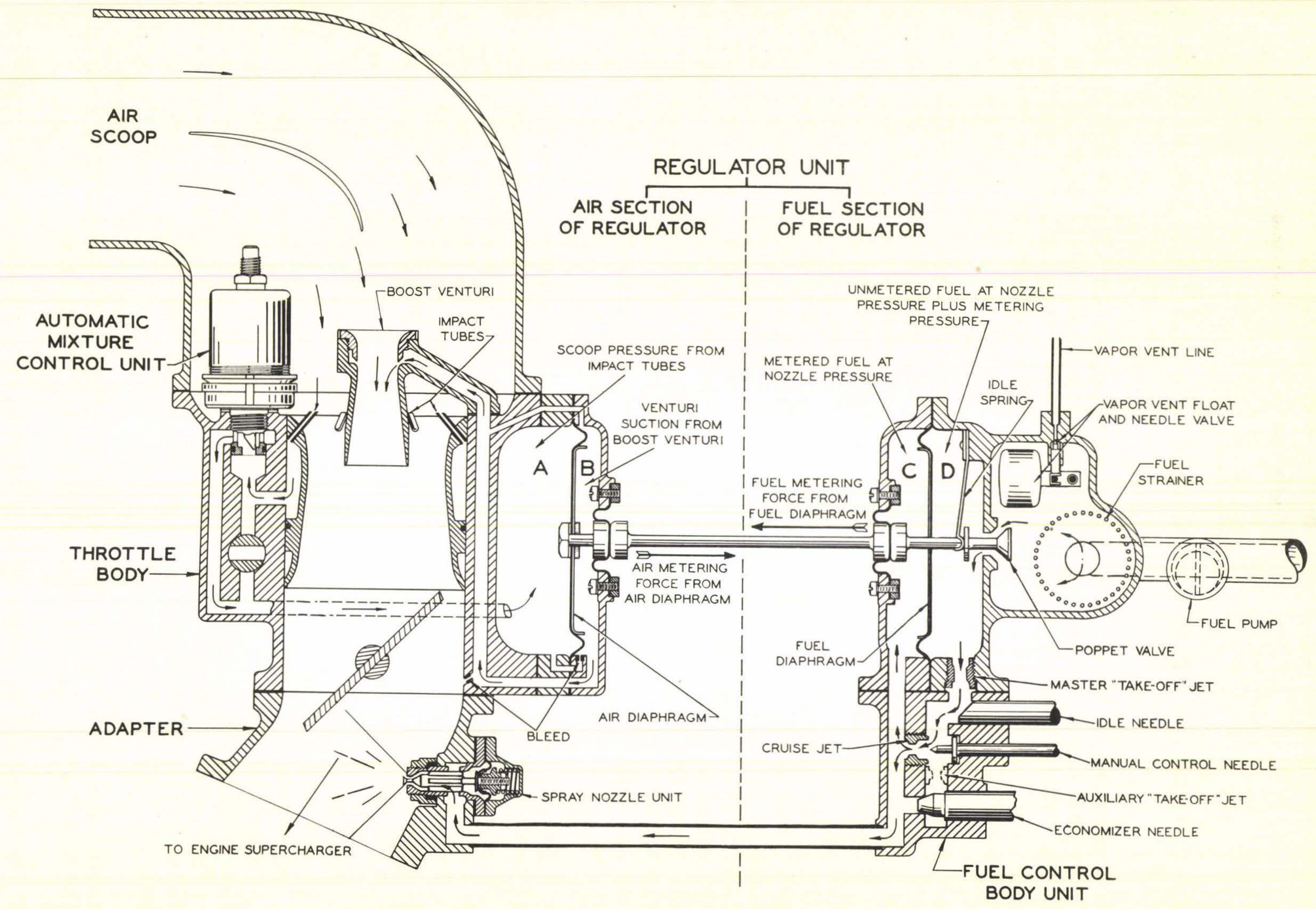


FIG. 20 DIAGRAM OF STROMBERG INJECTION CARBURETOR

formance.

A study of the carburetor impresses on one the necessity of a proper and adequate installation and rigging of the pilot's engine controls as well as the need for correct operation of these controls.

When considered as a functional part of the fuel system and having a working knowledge of the part the carburetor plays, it will be easier to isolate malfunction of the fuel system proper.

SHOULD THE CARBURETOR MALFUNCTION IT WILL BE NECESSARY TO REMOVE IT AND SEND IT TO A STATION EQUIPPED FOR ADJUSTING AND FLOW TESTING, BEFORE INSTALLATION FOLLOWING REWORK.

(Code # 433)

Stewart Warner
heater 790C

6" HG differential press. between manifold & adapter
Solenoid draws 1½ amps.
Igniter draws 10-12 amps.
Satisfactory operation at 21" HG. at 2100 RPM. in flight.
Heater starts in 2 mins. at 27" HG. man. press. on the ground

Air Overheat Switch - If over 350° F. - switches operate and breaks solenoid circuit.

Tightening torque 760 in lbs. for flexible expansion joint in line from heater.
Fuse wire - SW 2511 (350°F)
Igniter cut out 150°F.
Combustion chamber throws out at 600°F.
200 hrs. operation - take apart, clean & reassemble.
Fuel air ratio should be .111 to .06. Preferred is .075.

HEAT & VENT.

NORTH AMERICAN AVIATION Inc.

Heat & Vent. LECTURE

B-25 SERIES AIRPLANES

PREPARED BY *Fred L. Borke*

NOTE

THE INFORMATION CONTAINED IN THIS LECTURE WAS CORRECT AS OF MAY 15, 1942. REFER TO HANDBOOK OF OPERATION AND SERVICE INSTRUCTIONS FOR THE LATEST INFORMATION.

N A A

I N G L E W O O D, C A L I F O R N I A

I N D E X

I L L U S T R A T I O N S

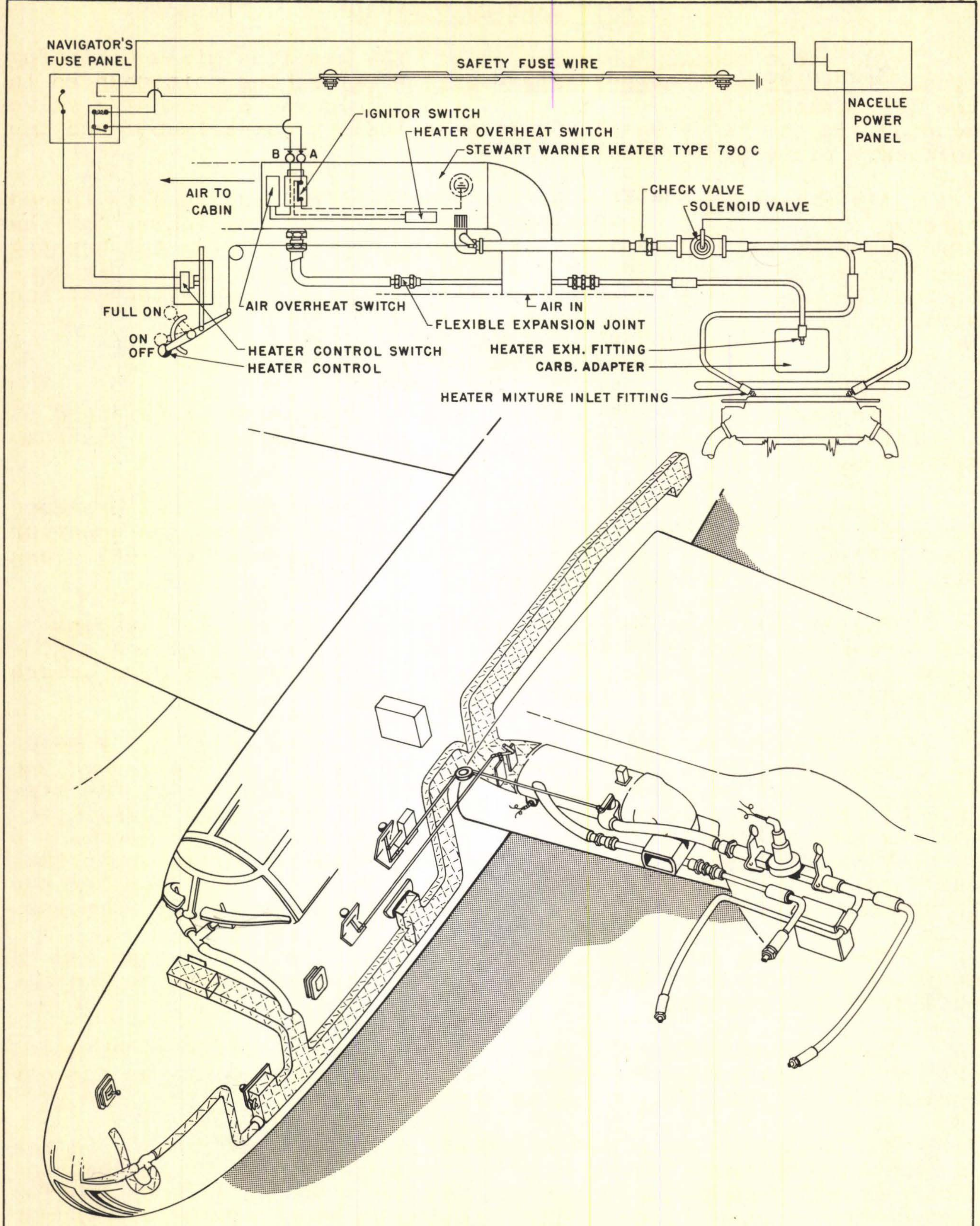


FIG. 1 HEATING AND VENTILATING SYSTEM (B-25C)

CABIN HEATING GENERAL

The cabin heating provided is of the gasoline mixture burning type. This system consists essentially of a heating unit mounted in the left center wing nose section, a solenoid valve and check valve mounted in the left nacelle engine accessory compartment and the necessary plumbing and controls.

Air enters the heater at the wing leading edge and is forced through the duct system by means of the air "ram" available. As the air passes by the heater, heat is transferred to it from the burning gasoline vapor in the core of the heater. From here the air is conducted through ducts to each normally occupied compartment of the airplane.

CABIN HEATING OPERATION

The gasoline air mixture supplied to the heater is obtained at the left engine supercharger section and is essentially the same mixture as supplied to the engine cylinders.

Approximately six (6) inches of mercury differential pressure between engine manifold and heater exhaust is required for superior heat output, but the heater will ignite and operate at less than six (6) inches of mercury differential.

The exhaust from the heater is returned to the left engine at the carburetor adapter, which is the low pressure side of the engine supercharger. This insures a positive mixture pressure drop across the heater at all engine powers except idling.

The mixture is ignited in the heater core, Fig. 2, by means of a "glow plug" B, which becomes energized electrically when the heater is turned on. This ignitor remains energized until the mixture is ignited and the heater core becomes hot enough to maintain its own temperature, at which time an ignitor switch (C) breaks the circuit to the ignitor (B). In this way the heater draws approximately one and one-half (1-1/2) amperes except when the ignitor is drawing current.The ignitor draws ten (10) to twelve (12) amperes.

The burning gases pass through the core of the heater and in so doing give up heat to the air which is being passed around the outside finned portion.

The ignitor switch (C) mentioned above is a micro-switch operated by a thermal element which changes its position due to the air temperature at the exhaust end of the heater.

The heater contains two overheat switches. Switch (D) is set to limit the maximum heater core temperature, so as to protect the heater itself from becoming too hot in the event of lack of airflow through the heater. Switch (E), located at the leaving air end of the heater, is set to limit the maximum air temperature leaving the heater.

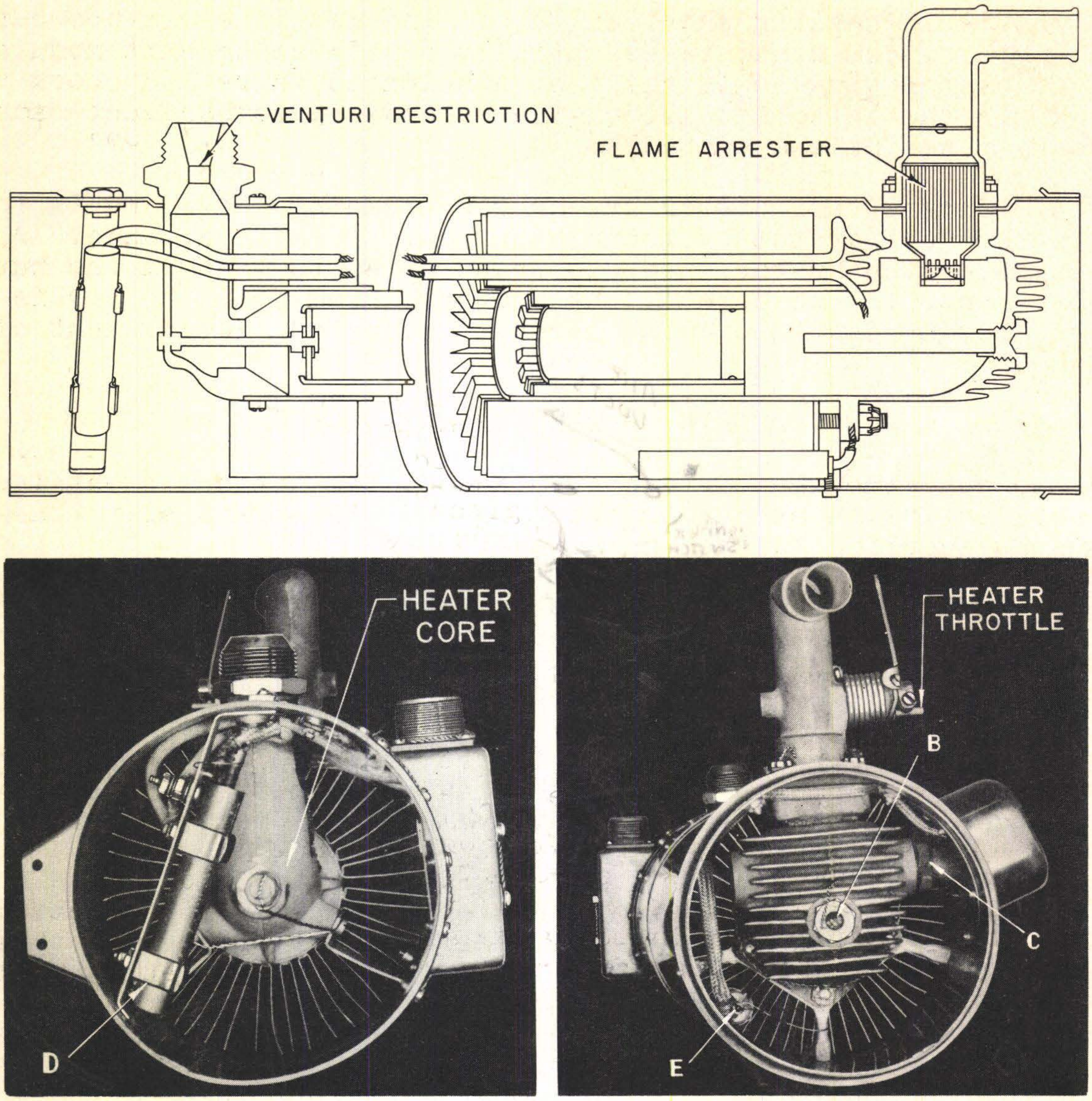


FIG. 2 HEATER UNIT

The heater should start in approximately two (2) minutes at twenty-seven (27) inches of mercury manifold pressure on the ground.

Operation will be satisfactory during glide at twenty-one (21) inches of mercury manifold pressure at two thousand one hundred (2100) engine RPM.

The heater will operate better at lean engine mixtures than under rich mixture conditions. Under unusually rich mixture conditions, especially at rated power, the heater control throttle may have to be closed partially to reduce the mixture flow through the heater. The above would also apply in attempting to start the heater at high manifold pressures.

HEATER CONTROLS

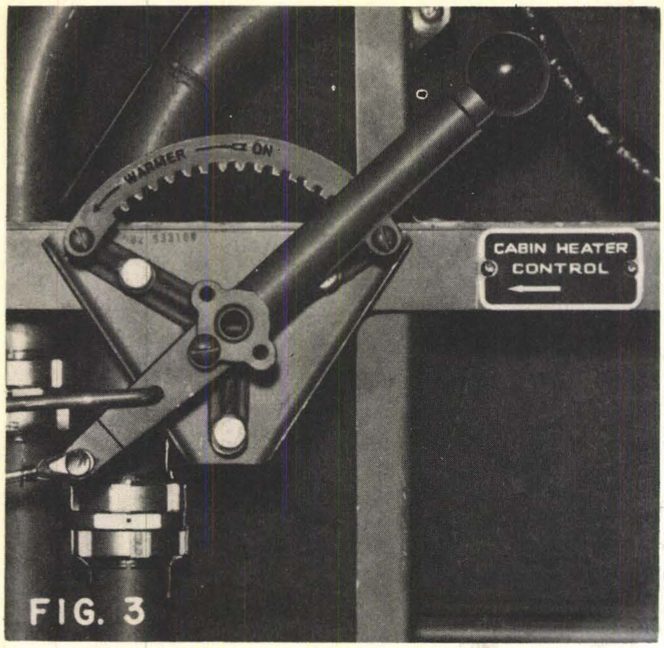


FIG. 3

There is only one control for the heater to be operated by the navigator. It is located on the left side of the navigator's compartment, Fig.3, opposite the navigator's table. It is either "off", "on", or somewhere between "on" and "full on", indicated by the word "warmer" on the control sector.

When the control is moved to the "on" position,the ignitor plug at the heater becomes energized; the solenoid valve in the mixture inlet line is also energized, opening and permitting mixture to flow to the combustion chamber of the heater.

Air always will be admitted through the heater unit, and it will or will not be heated depending on whether the heater is "on" or "off".

There is an overheat switch or temperature limiting switch which will automatically limit the air temperature leaving the heater to approximately three hundred (300) degrees F. This is to prevent damaging ducts and duct insulation. When the air temperature reaches three hundred (300) degrees F., the electric circuit to a solenoid valve located in the mixture inlet line to the heater will be broken, closing the solenoid valve and shutting down the heater. However, the heater will again operate automatically as soon as the temperature decreases,providing the main control is kept in the "on" position.

CABIN HEATER ACCESSORIES

1. Heater Control:

The heater control, Fig. 3, located on the left side of the navigator's compartment operates a micro-switch by means of a cam which turns the heater "off" or "on" as indicated on the control quadrant. This switch may become out of adjustment and may be readjusted by loosening the two screws which retain it and move it up or down, closer to or farther away from its operating cam.

In starting the heater, it may be advantageous to vigorously move the heater control handle back and forth between its "on" and "full on" position. At high manifold pressures the heater will start better if the control is not beyond the "on" position.

2. Solenoid Valve:

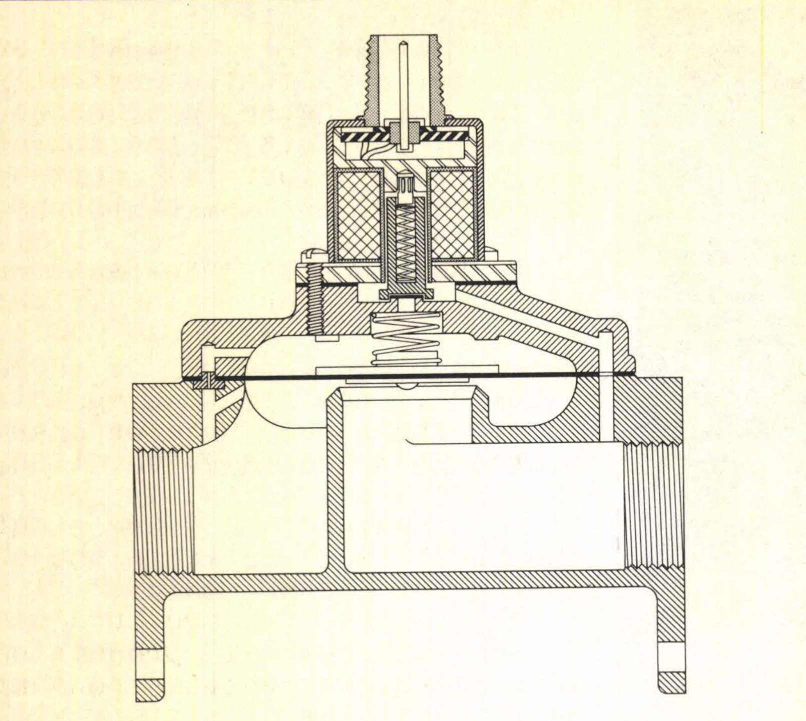


FIG. 4

The solenoid valve, Fig. 4, is located in the left engine accessory compartment on the engine mount cross tube. Its primary purpose is to provide a means of shutting off the mixture manually as well as automatically.

This valve is of the diaphragm type and is spring-loaded in the closed position. When energized it draws approximately one and five tenths (1.5) amperes current.

The valve is located as close as possible to the mixture source so as to leave a minimum of inlet line filled with mixture when the heater is inoperative.

3. Check Valve:

A check valve, Fig. 5, is installed in the mixture inlet line. This prevents reversal of flow through the system which might otherwise occur at idling speeds (extremely low manifold pressures).

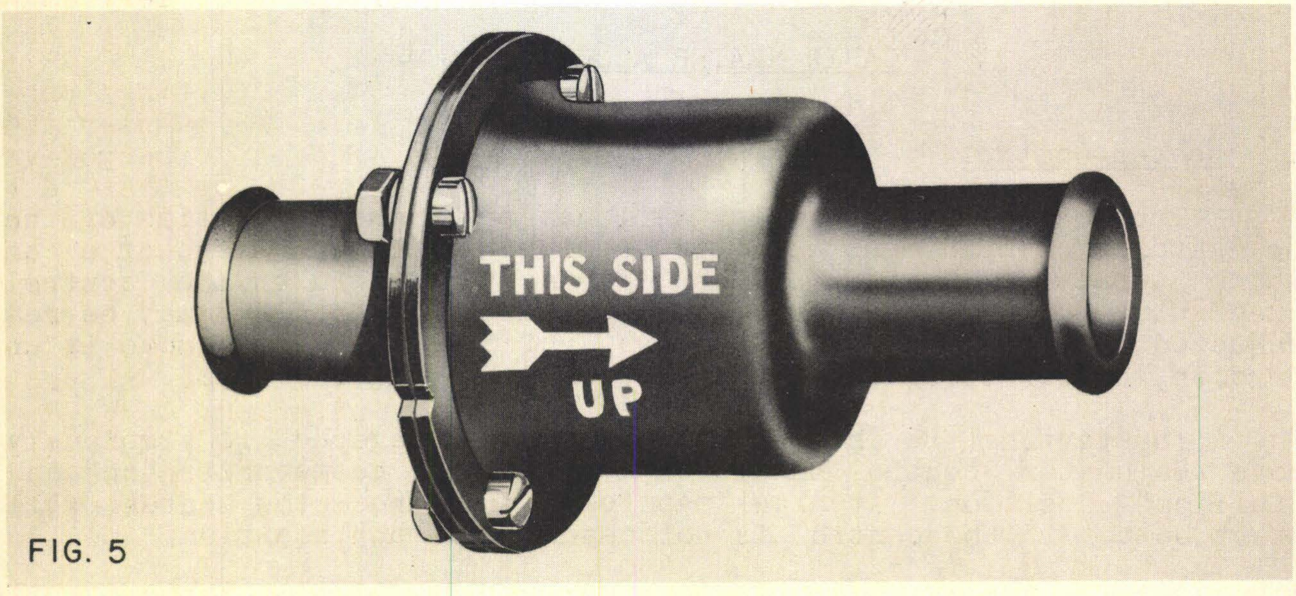


FIG. 5

4. Inlet adapter fitting:

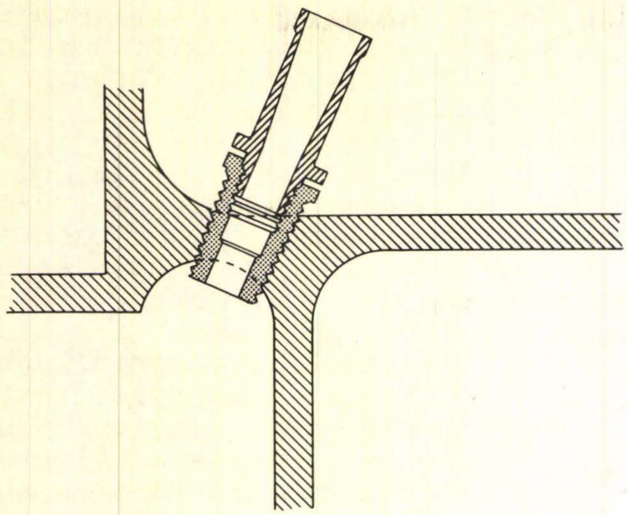


FIG. 6

The two (2) inlet adapter fittings are located radially on the left engine supercharger section, just aft of the engine baffle, and four (4) degrees below the centerline of thrust.

The engine manufacturer has supplied each engine, right and left, with suitable holes for the installation of these fittings. All engines on this model airplane, therefore, are suited for heater connection.

It should be noted that the bushings supplied with the engine for heater adapter fittings are not standard bushings but have a special projection into the blower section so that heavy particles of mixture will not be blown into the mixture lines from the inside surface of the supercharger section.

5. Exhaust Adapter Fittings:

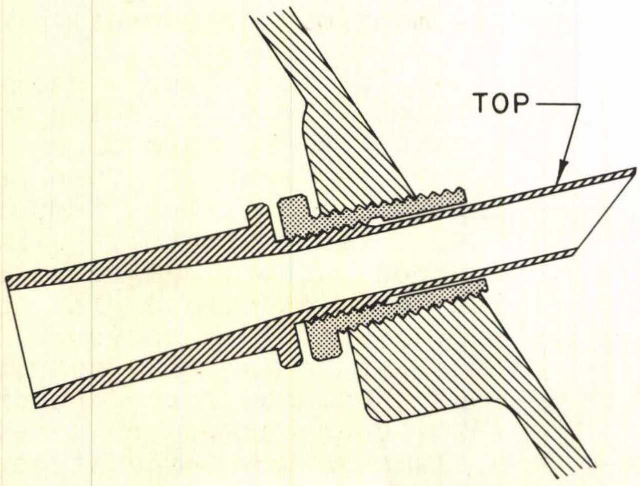


FIG. 7

The exhaust adapter fitting is installed in the mixture thermometer hole on the carburetor adapter on the left engine.

This fitting projects into the adapter and is cut off at forty-five (45) degrees so that air flow past it will tend to increase the suction on this side of the system. The fitting is marked "top" on the side to be on top when fitting is properly installed.

It may be necessary to use shims to maintain this position.

6. Exhaust line expansion Joint:

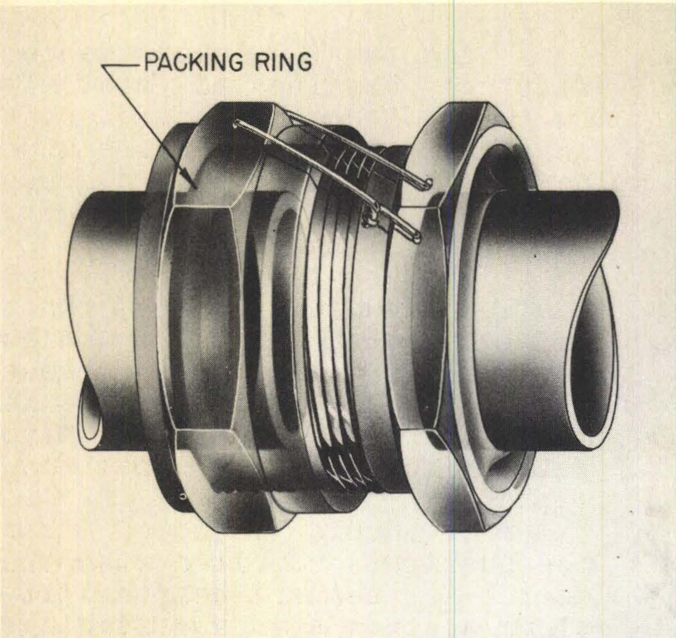


FIG. 8 EXPANSION COUPLING

An expansion joint, Fig. 8, has been provided in the exhaust line from the heater to the engine. This is located in the left wing center section leading edge just forward of the heater.

The purpose of this joint is to permit twisting and general movement of the exhaust line due to high temperature changes.

The packing material used is of asbestos wick type, treated with graphite solution. The graphite will give a tighter seal with less pressure on the nut. Too much pressure on the nut in assembling the joint may also crush the end of the tubing.

The maximum recommended torque in assembling this joint is seven hundred and sixty (760) inch pounds.

7. Heating System Safety Devices:

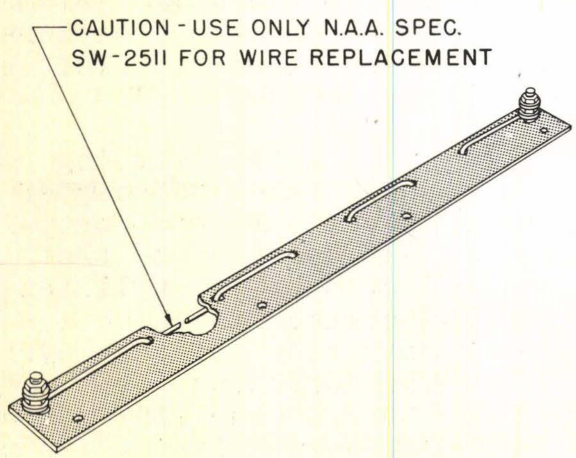


FIG. 9

A. Inlet line: The heater and solenoid valve inlet hose is of a self-sealing type to protect against gun fire.

B. To protect against fire in the wing being aggravated by mixture from the heater, a wire or fuse having a low melting temperature (approximately three hundred (300) degrees F.) has been provided in that compartment. Whenever the temperature in this compartment becomes three hundred (300) degrees F., or whenever a flame or hot exhaust gases impinge on this wire, it will melt, breaking the electrical circuit to the heater, closing the solenoid valve.

It should be noted that

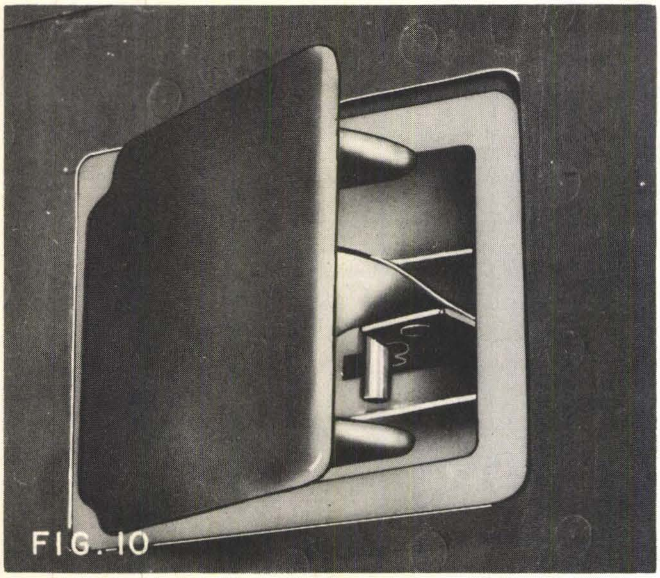
although this wire is quite well protected against damage from any source except heat, it may become severed, in which case the heater would not operate.

In replacing this wire, specification tags as attached to each wire assembly shall be adhered to.

Ordinary solder wire is not satisfactory.

VENTILATING GENERAL

For ventilating the airplane in the air, the same duct system is used as in heating.



The controls for this will be explained later in this description.

In addition to the above, the pilot, co-pilot and bombardier have individual ventilators which, when open, scoop air from the outside. These are independent of the other duct system and may be kept on or off regardless of whether the heating system is on or off.

The pilot's ventilators are located one on either side of the ship just aft of the instrument panel.

The bombardier's ventilator is located on the right side, under the map case.

All are similar and are controlled by moving a lever forward to open.

Ground ventilation is obtained by opening the various windows, entrance hatches, pilot's escape hatch, camera doors, etc.

AIR OUTLET CONTROLS

Air outlets are located in the bombardier's, pilot's, navigator's and radio operator's compartments. All outlets can be opened or closed by the occupant of the compartment; position of control is indicated by name plate at each outlet.

All outlets are equipped with diffusers of the Anemostat type.

(1) Bombardier's compartment: The air outlet and control for

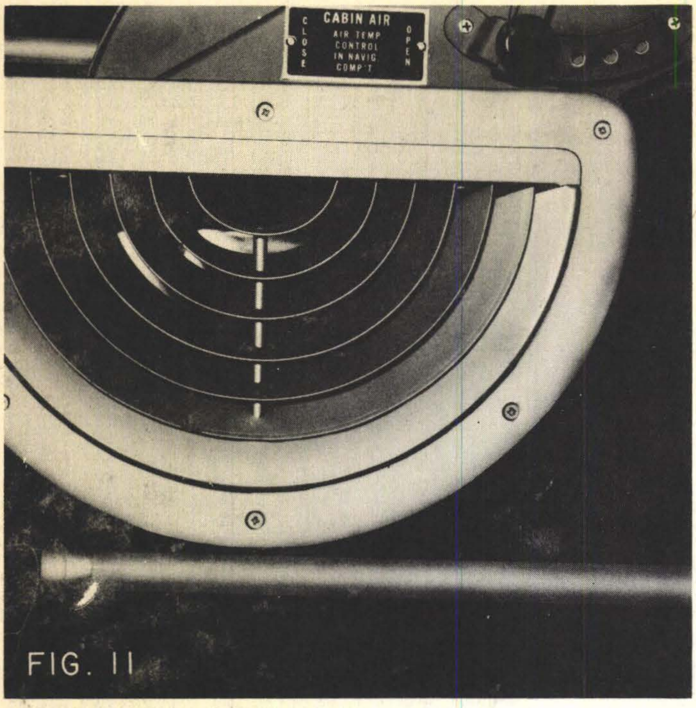


FIG. 11

same is located on the left side of the compartment near the floor.

(2) Pilot's Compartment: The pilot's and co-pilot's air outlet is located just forward of the control pedestal, near the floor. The control is of the push-pull type, located below the control pedestal switch panel on the pilot's side.

(3) Navigator's Compartment: The navigator's outlet is located on the left side of the ship, inboard of the chart well.

(4) Radio operator's Compartment: The radio operator's outlet is located on the left side of the ship, aft of the radio operator's table.

It should be pointed out, that to heat this compartment satisfactorily, the door to the rear of this station must be closed.

A curtain has been installed at the aft end of the crawl passage over the bomb bay. It is necessary that this be closed to give satisfactory cabin temperature when heating.

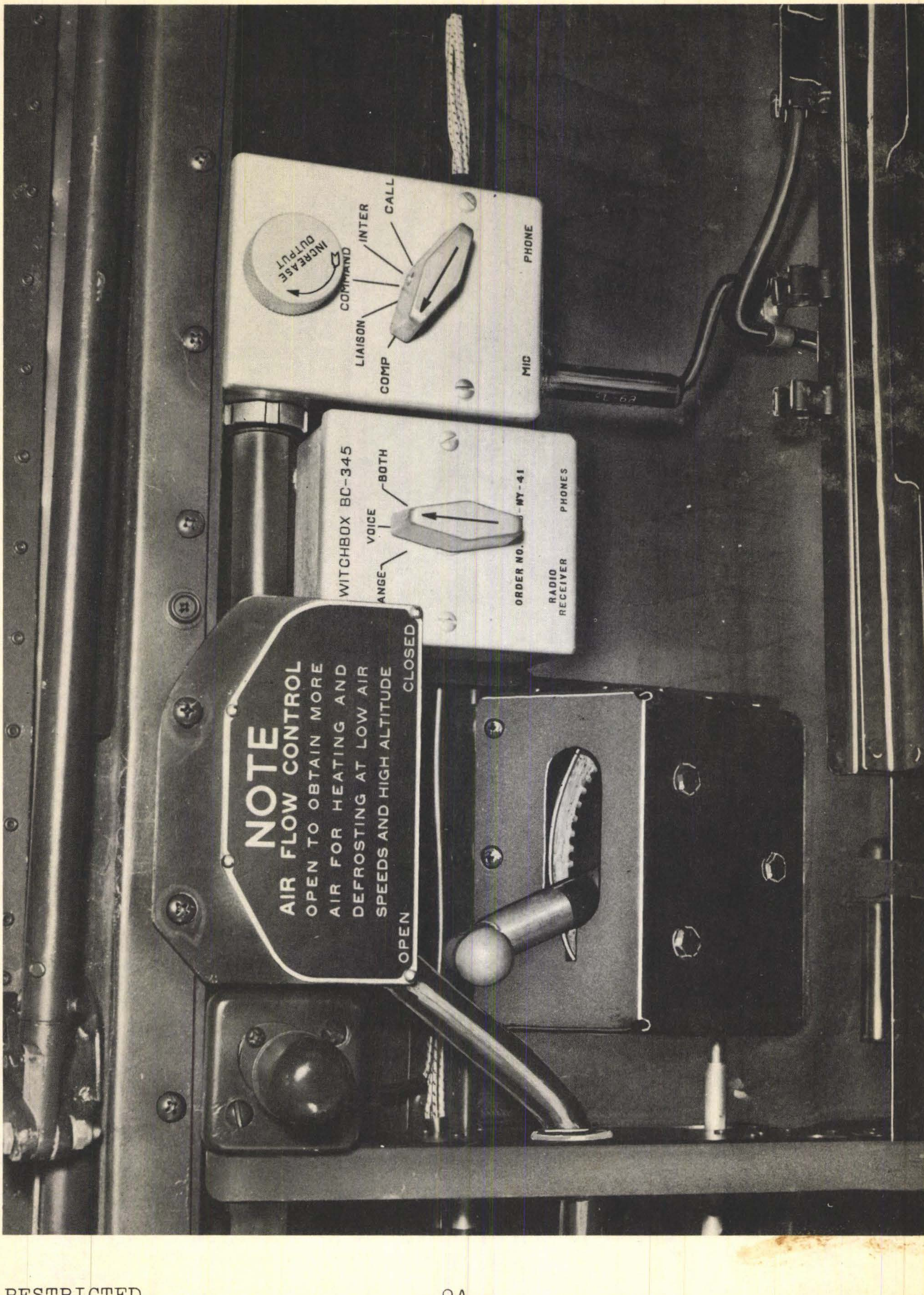
It should also be pointed out that satisfactory heating cannot be obtained if the gun mounts in the bombardier's compartment are left open.

DE-FROSTING SYSTEM GENERAL

Frost may be prevented from forming on the pilot's windshield, bomb sight window, and vital parts of the bomb sight, by means of warm air from the heating system. The air temperature, as in case of cabin heating, is controlled by the navigator. A small transparent door is provided in the bombardier's enclosure for clearing the bomb sight window.

DE-FROSTING SYSTEM CONTROLS

These controls differ on ships equipped with A. F. C. Equipment and those equipped with Sperry A-3 automatic pilots.


INCREASE OUTPUT
COMP
LIAISON
COMMAND
INTER
CALL
MIC
PHONE
WITCHBOX BC-345
VOICE
BOTH
RADIO RECEIVER
PHONES
NOTE
AIR FLOW CONTROL
OPEN TO OBTAIN MORE
AIR FOR HEATING AND
DEFROSTING AT LOW AIR
SPEEDS AND HIGH ALTITUDE
OPEN
CLOSED

On A. F. C. E. ships, pilot's windshield air is controlled by two valves, one each side of the center frame at the base of the windshield. They are either "on" or "off" as indicated.

On Sperry A-3 equipped ships, pilot's windshield air is on at all times, there being no shut-off or control.

Under extreme conditions more air will be available at the windshield, if the pilot's air outlet is closed. Still more air will be available if the navigator's air outlet is closed.

Bomb Sight Window: Air is supplied to bomb sight window at all times. Under extreme conditions more air will be available if the bombardier's air outlet is closed.

Bomb Sight: The control for warming or de-frosting the bomb sight is integral with the "tee" fitting to which the hand-held flexible tubing, stowed on the left side of the compartment, is attached when it is necessary to apply air to the sight. The valve is "off" or "on" as indicated on the valve.

A restriction or orifice is provided in the Y duct immediately after the heater. This restriction may be opened up or made less by means of a control located just to the left of the pilot's seat.

Its main function is to allow more air to enter the duct system at high altitudes or low cruising speeds, or both when the "ram" effect forcing the air through the duct system is materially reduced. This extra amount of air is of value especially in de-frosting the windshields and bomb sight window.

MAINTENANCE AND REPAIR OF THE HEATING SYSTEM

Heater: The heater is accessible from the door in the top of the left center wing nose.

It may be removed by first disconnecting the exhaust line,from the inboard end of the heater, (this connection is accessible from the access door on the lower side of the wing nose section) the inlet line and the control cable at the heater control valve. The retaining clamp at the outboard end of the heater and two bolts supporting it at the middle may be removed and the heater removed from the door at the top of the wing.

Except for minor adjustments it is suggested that the heater be overhauled by the manufacturer until such time as personnel becomes sufficiently trained to do this work. It is not expected that a great deal can go wrong with this type of system.

When the Heater Fails to Ignite:

(a) Check the voltage at the ignitor terminal. It should not be less than twenty-two (22) volts. If it is less, check the source voltage. The generators should preferably be running across the battery, otherwise the battery voltage is apt to be too low. If the source voltage is satisfactory, then an excessive voltage drop is occurring somewhere in the circuit to the heater,or within the heater across the ignitor thermal switch. Check the voltage at the heater terminal to determine whether the latter is the case. If it is, replace the ignitor thermal switch, according to the instruction contained in the Stewart-Warner Service Bulletin, Form 10,571.

(b) Check the current to the heater by an ammeter. If the voltage at the ignitor is satisfactory but the current to the heater is not ten amperes or more, the ignitor is burned out or its ground wire is broken, and the ignitor should be replaced.

(c) Check the operation of the solenoid valve. When the heater electrical switch is turned off and on, a click should be faintly audible in the solenoid valve. If it is not, check to see that the proper voltage is reaching the electrical terminal of the valve. If it is not, check the voltage at the prong B of the heater which is connected to the solenoid valve. If there is no voltage at this point, one or both of the overheat switches within the heater are probably defective and should be replaced.

If no click within the valve is heard although there is proper voltage reaching the valve terminal, the valve solenoid coil should be checked for open circuit by an ammeter. If the coil draws in the neighborhood of a quarter to half of an ampere,then the valve should be removed and tested. Foreign material may have entered the valve and clogged one of the small bleed passages or caused the valve plunger to become stuck. If it is necessary to disassemble the valve, this should be done according to instructions contained in the service bulletin, "Instructions for the Operation and Maintenance of Solenoid Valves", Form 10,570, which is obtainable from the Stewart-Warner Corporation.

(d) To check continuity of the protective fuse wire circuit, move the control handle at the quadrant "on" and "off" several times and observe the heater relay which is located in the top of the navigator's fuse box. If this relay opens and closes its contacts the fuse wire is not broken.

(e) In any case, do not expect the heater to operate when the engine manifold pressure is less than twenty (20) inches of mercury.

Decrease of Heat Output:

The heat output will decrease if the heater is made to burn very rich mixtures. It will in general operate on fuel-air ratios of between .11 and .06, but will operate best on a fuel-air ratio of

about .075.

The heat output of the heater is apt to decrease gradually as it is operated over a period of time. The aviation gasoline burned contains a quantity of lead, which deposits itself upon some of the surfaces within the heater, thus impeding the flow of mixture. Therefore, the heater should be cleaned out periodically.

The heater manufacturer states that the heater will operate approximately two hundred (200) hours before a clean out is necessary. The heater should be replaced with a spare and returned to the manufacturer for cleaning.

The heater will sometimes purge itself of lead deposits and so may go indefinitely without need of cleaning.

A simple operation which will in many cases increase the heat output of a heater that has been operated for some time is to clean out the throat of the restricting hole in the exhaust fitting at the heater.

To obtain service bulletins, or in case you encounter some difficulty in service matters on the Stewart-Warner Heater, write or telegraph to: Stewart-Warner Corporation, 1826 Diversey Parkway, Chicago, Illinois, Attention: Mr. E. J. Donohue.

SERVICING THE VENTILATING SYSTEM

The air after leaving the radiator and mixing chamber, enters the fuselage to a "Y" duct which diverts a portion of it aft to the radio operator and the balance forward to the navigator, pilot, and bombardier. This "Y" duct is located at the junction of the left wing and fuselage. The air diverted aft and that diverted forward is controlled by a semi-permanent splitter valve, located in the "Y" duct, which has been adjusted at the factory to give normal distribution requirements. However, if it is desired to change this distribution, it may be done by removing one screw on the forward face of the "Y" duct and moving the splitter arm "up" to divert more air forward, and down to divert more air aft.

There is also a "tee" duct with a similar splitter as above for diverting some of the air up to the pilot's air outlet and windshield de-frosting duct, and some forward to the bombardier's outlet, bomb sight window de-frosting duct, and bomb sight de-frosting duct.

This "tee" duct is located at the left side of the ship at the entrance of the passageway to the bombardier's compartment. Moving this splitter arm down will divert more air forward, and moving it up will divert more air to the pilot's duct.

This valve has also been set at the factory for normal distribution and may be changed by removing one screw.

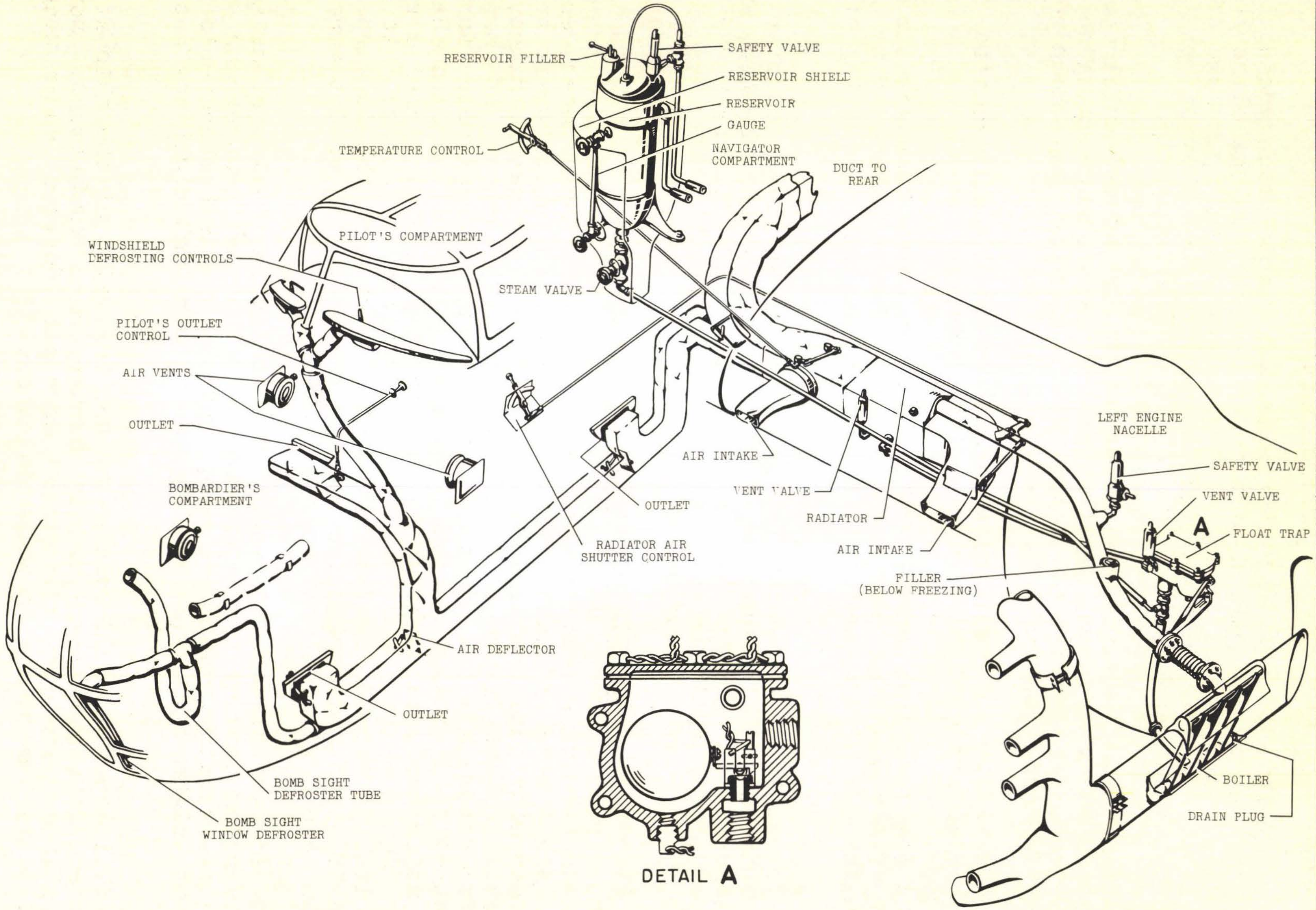


FIG. 12 HEATING AND VENTILATING SYSTEM (B-25, B-25A AND B-25B)

ADDENDUM I

Items peculiar to B-25, B-25A and B-25B Airplanes.

STEAM-HEATING - GENERAL

A steam-heating system is provided. The system consists essentially of a boiler in the engine exhaust tailpipe, a radiator in the left wing center section, a water reservoir in the navigator's compartment, a condensate trap on the firewall and the necessary safety valves, air vent valves, etc.

Air enters the radiator at the wing leading edge and is forced through the duct system by means of the air "ram" available. As the air passes the radiator, heat is transferred to it from the steam inside the radiator. From here the air is conducted through ducts to each normally occupied compartment of the airplane.

STEAM-HEATING - OPERATION

The cycle of the steam part of the system is as follows:

Let us start with the ship on the ground, left engine not running, and five (5) quarts of water in the reservoir.

First the valve on the bottom of the reservoir is opened, and the water goes down by gravity to the boiler; the vertical distance of "head" here is about thirty (30) inches. Air which may be in the system is forced out through the air vent valves, which are open when cold and closed when hot. Air is admitted to the top of the reservoir through the overboard vent line. When the five (5) quarts of water reach the lowest part of the system, the boiler will be completely full and about two (2) quarts of water will have backed up in the steam line into the radiator.

The float ball in the condensate trap is up, since the trap is probably full of water, water having entered from the radiator.

Now when the left engine is started, the boiler, being in the direct path of the exhaust gases, becomes hot very rapidly and steam is generated. Water in the steam line is carried into the radiator, and water from the radiator drains through the open float trap. The air vent valves close when hot water or steam comes in contact with them. The steam pressure forces the water back into the reservoir, so that after about two to four minutes from time the engine was started, practically all of the water is back in the reservoir. Steam continues to be generated rapidly and unless sufficient air is supplied to condense it, the water will soon come near the boiling point in the reservoir and will be eventually evaporated.

When the ship takes off, air is forced through the radiator by "ram" and the steam is condensed. The condensate drains to the

float trap where it collects until sufficient to raise the float ball and return to the system.

When the ship is flying and sufficient air is passed through the radiator, little or no water is lost in this continuous process of evaporation and condensation.

If it is desired to stop the cycle at any time, shut off the valve at the lower end of the water reservoir in the navigator's compartment. Pressure will immediately build up in the boiler, and safety valve will relieve it at approximately 20 lb./sq.in. Water which was not trapped in the reservoir will be lost through the safety valve.

VENTILATING - GENERAL

For ventilating the airplane in the air, the same duct system is used as in heating.

The controls for this will be explained later in this description.

In addition to the above, the pilot, co-pilot, and bombardier have individual ventilators which, when open, scoop air from the outside. These are independent of the other duct system and may be kept on or off regardless of whether the heating system is on or off.

The pilot's ventilators are located one on either side of the ship just aft of the instrument panel.

The bombardier's ventilator is located on the right side, under bomb data case.

All are similar and are controlled by the turning of a thumb screw.

Ground ventilation is obtained by opening the various windows, entrance hatches, pilot's escape hatch, camera doors, etc., and on the B-25 and B-25A, the tail gunner's clam shell doors.

Do not open the bombardier's or tail gunner's escape hatches to obtain ventilation.

STEAM-HEATING CONTROLS

The only steam control is the steam shut-off valve previously mentioned. This valve is mounted on the bottom of the water reservoir in the left rear corner of the navigator's compartment, just inboard of the wing. It may be used for any of three reasons: (1) To stop the generation of steam while in flight, either because it is too warm, to conserve water, or because of a leaky reservoir which necessitates isolating it from the rest of the system.

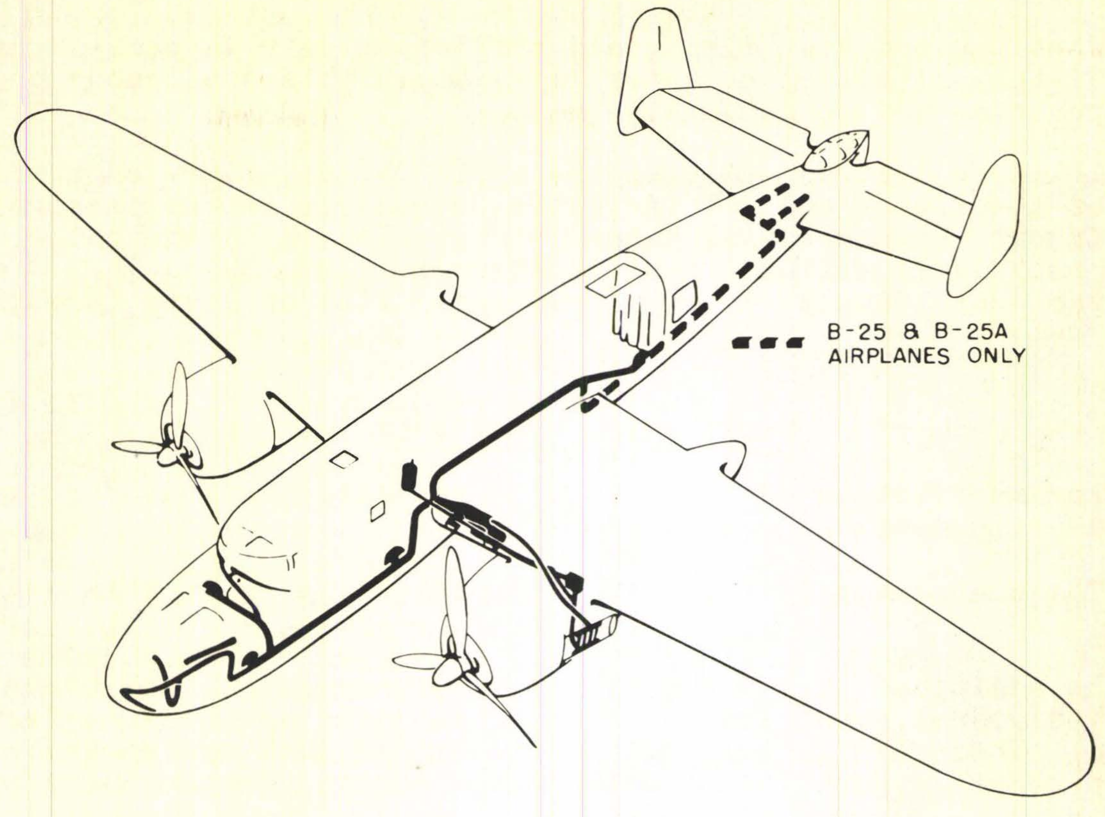
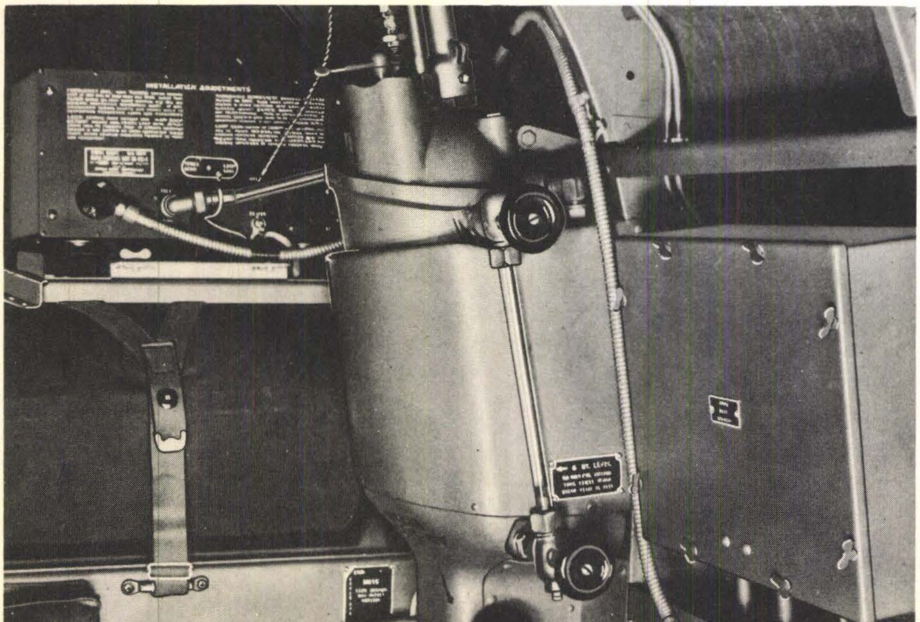


FIG. 13 VENTILATING SYSTEM (B-25, B-25A AND B-25B)



(2) When coming in to land, the weather may be mild enough or the stop of short enough duration, so that it will not be necessary to drain the whole system; therefore, this valve can be closed and only that water left in the boiler, drained. (3) When starting the system in extremely cold weather this valve may be closed and only a small quantity of water permitted in the boiler, thereby generating steam more quickly with less danger of freezing.

RADIATOR SHUTTER CONTROL

There is a shutter provided at the air inlet to the steam radiator. The control (Fig.15) for this is located just to the left of the pilot's seat on the left side of the airplane. It is accessible to the navigator as well as the pilot.

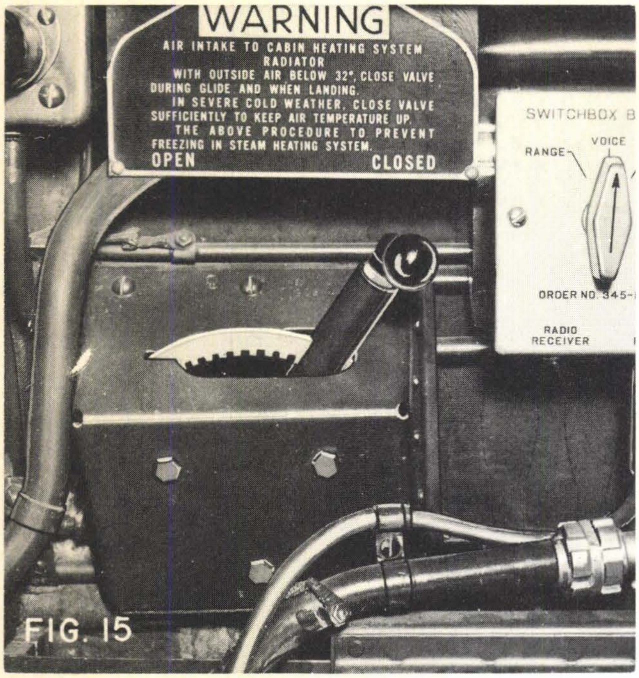


FIG. 15

This control has the following functions:

(1) The primary function of this control is to minimize freezing in the radiator.

In weather below freezing, and if a descent is made with very little or no power on the left engine, the control should be in the completely closed position--shutting off the air to the radiator. At the condition of low or no power in the left engine, there is apt to be very little steam generated; and consequently a large amount of subfreezing air into the radiator would possibly cause freezing and stoppage of the system.

(2) Although the control is set to give optimum air flow for maximum heat output at cruising at 15,000 feet in the full open position, it may be desirable at some time to have the air entering the cabin at a higher temperature; if so, the shutter should be partly closed. Also in extremely cold weather, say 40 below, and at high speeds at lower altitude, the "ram" will be considerably higher with consequent higher air flow, unless the shutter is partially closed. This large quantity of air could not be sufficiently heated, thereby resulting in a cold cabin.

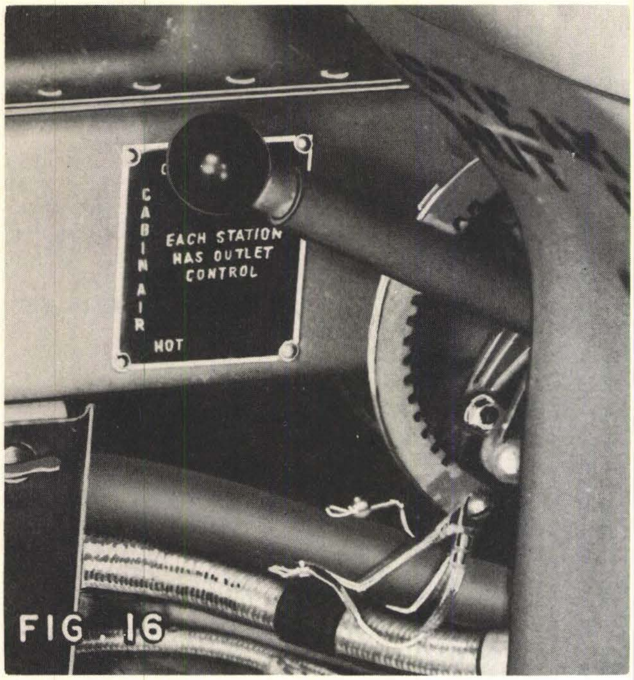
(3) In starting the system on the ground in weather below freezing, always close radiator shutter until the system warms up. There may be sufficient propeller blast to start freezing, since the inlet scoop is located in the propeller blast.

(4) When flying without personnel in navigator's compartment, it is possible for pilot to shut off all air from this source. If the heating system is working and the shutter is closed, very little or no heat will enter the ship.

However, with the shutter closed there will still be enough air for normal ventilation requirements.

HOT AND COLD AIR CONTROL

This control is located in the navigator's compartment, on the shelf on the left side of the ship, just inboard of the wing, Fig.16. It is accessible only to the navigator.



(1) This control operates two interconnected gates in a duct or sort of mixing chamber. By operating this control, all hot air may be admitted to the mixing chamber from the radiator, all cold air may be admitted from the cold air inlet in the leading edge of the wing next to the fuselage, or some of both may be admitted, giving a mixture. Whatever the temperature of the air in this duct due to the setting of this control, will be the temperature of air entering the cabin.

(2) When the control is in the "HOT" position, the air from the cold air inlet is shut off and only heated air will be admitted, if the heating system is operating.

(3) It may be well to point out here as well as further on in this description, that very little "cracking" or opening of the cold air valve will cause considerable change in air temperature. This has been made a close fitting valve, and should be carefully set straight across the opening when in the closed position ("Hot" position).

(4) It can be seen from the discussion above that normally the navigator has control of the air temperature. The only time he does not, is when the pilot closes the shutter in radiator air inlet.

Therefore if any occupant in any other compartment wishes a change in air temperature, he should notify the navigator.

AIR OUTLET CONTROLS

Air outlets are located in the bombardier's, pilot's, navigator's and radio operator's compartments on the B-25, B-25A and B-25B, and in the tail gunner's station on the B-25 and B-25A only. All outlets can be opened or closed by the occupant of the compartment; position of control is indicated by name plate at each outlet.

All outlets are equipped with diffusers of the Anemostat type, except the outlet on the tail gunner's station in the B-25 and B-25A.

(1) Bombardier's compartment: The air outlet and control for same is located on left side of compartment near the floor.

(2) Pilot's compartment: The pilot's and co-pilot's air outlet is located just forward of the control pedestal, near the floor. The control is of the push-pull type, located below the control pedestal switch panel on the pilot's side.

(3) Navigator's compartment: The navigator's outlet is located on the left side of ship, inboard of the chart well.

(4) Radio operator's compartment: The radio operator's outlet is located on the left side of ship, opposite the radio operator's desk.

It should be pointed out, that to heat this compartment satisfactorily, the curtain to the rear of this station must be closed.

(5) Tail gunner's station in B-25 and B-25A only: There are two air outlets, one each side of and below the seat.

In cold weather when the station is not occupied, these outlets should be closed to conserve heat for other compartments.

DE-FROSTING SYSTEM - GENERAL

Frost may be prevented from forming on the pilot's windshield, bomb sight window, and vital parts of the bomb sight, by means of warm air from the heating system (Fig. 12).

A separate control regulates the air supply to each of the two windshield sections, and to the bomb sight, whereas the bomb sight window receives air at all times. The air temperature, as in case of cabin heating, is controlled by the navigator. A small transparent door is provided in the bombardier's enclosure for clearing the bomb sight window.

DE-FROSTING SYSTEM - CONTROLS

Pilot's Windshield: Two valves, one each side of the center frame at the base of the windshield, are provided. They are either "on" or "off" as indicated.

Under extreme conditions more air will be available at the windshield, if the pilot's air outlet is closed. Still more air will be available if the navigator's air outlet is closed.

Bomb Sight Window: Air is supplied to bomb sight window at all times. Under extreme conditions more air will be available if the bombardier's air outlet is closed.

Bomb Sight: The control for warming or de-frosting the bombsight is integral with the "tee" fitting to which the hand-held flexible tubing, stowed on left side of compartment is attached when it is necessary to apply air to the sight. The valve is "off" when the "tee" fitting is turned upward.

SERVICING STEAM HEATING SYSTEM

It is difficult to specify how the steam system shall be serviced; precautions which will be necessary under extreme temperatures will be unnecessary at normal temperatures. Judgment can be used, however, as to when to drain the whole system, part of the system, or when not to drain it. The servicing can be described then under two conditions: Weather below freezing and weather above freezing.

(1) Weather Below Freezing: (System Dry)

(a) Starting System:

1. Open valve marked "steam shut off" on bottom of reservoir in navigator's compartment and insert and lock drain plug. The drain plug on the B-25 and B-25A is located on the lower left forward side of the left firewall, whereas on the B-25B the drain plug is located at the lower rear corner of the boiler assembly, accessible from outside the cowling. Close radiator air intake shutter. (Control in pilot's compartment).

2. Add two (2) quarts of solution of fifty (50) percent distilled water and fifty (50) percent alcohol (by volume) to reservoir and allow to drain to boiler.

3. After left engine is started and the system warms up, add four (4) quarts of hot distilled water to reservoir and open pilot's radiator shutter control.

4. Be sure that both valves at top and bottom of water gauge on reservoir in navigator's compartment are open to give proper water level reading.

(b) Draining System:

1. Drain system when weather is below freezing and airplane is not to be operated. Judgment should be used in draining the system during stops of short duration.

2. To drain system entirely, open steam shut-off valve at bottom of reservoir, and remove drain plug located on forward lower left side of left firewall of the B-25 and B-25A, and on the boiler assembly of the B-25B.

3. During stops of short duration it may be desirable to drain that water which is in the boiler. In this case the steam shut-off valve will have been closed immediately after landing or before, trapping most of the water in the reservoir.

(2) Weather Above Freezing: (System Dry)

(a) Starting System:

Prior to starting left engine, open valve marked "steam shut-off" below reservoir, and put five quarts distilled water into reservoir.

(b) Draining System:

The system need be drained only when it is desired to flush system of sediments, etc.

(3) General Service Items:

(a) Occasionally remove the drain plug in the bottom of the float trap located on the forward left side of left firewall, when draining system.

(b) At intervals remove cover from float trap, and thoroughly clean.

(c) The water level gauge on the reservoir (Fig.14) may be cleaned by removing the plug on the bottom of the lower valve swabbing the inside of the glass.

(d) At intervals the safety valves should be checked by air pressure. They should relieve at approximately 12 to 13 pounds air pressure or 20 pounds steam pressure.

(e) If the air vent valves do not shut off when exposed to steam, or if they do not open when cold, they are probably clogged. They are a sealed unit. Care should be taken in blowing them out, as excessive air pressure may cause damage beyond repair.

(f) The AN-882 hose connections of the steam line (large 1-1/2 diameter line from boiler to radiator) will probably have to be replaced at 100 hour intervals.

(4) General Precautions:

(a) Whenever possible, always admit water to the boiler before starting the left engine.

(b) Drain system when still hot, especially in cold weather to prevent freezing.

(c) In event of a leak in the reservoir in the navigator's compartment, close steam shut-off valve.

(5) Differences in System of B-25 and B-25B:

The only difference in the heating and ventilating system on the above airplanes is the steam boiler located in the exhaust

tailpipe. On the B-25B the drain plug for the system is located on the bottom rear corner of the boiler, outside the left tailpipe assembly. The system will be drained by removing this plug. Other draining procedure is the same on all models of this contract.

The boiler in practically all airplanes in service now is the flat waffle-like "pin" type. This boiler is very efficient as a heat transfer medium, but has not been very satisfactory from a life standpoint. It is, therefore, being replaced with one of tubular design. There are several of these already in service and apparently they are a substantial improvement. This boiler is made of 4 vertical 1-1/2" diameter tubes welded between 2 horizontal 1-1/2" diameter tubes as headers. All material is of corrosion resistant steel. This unit is interchangeable with the original pin type, and will be installed on the B-25 and B-25A airplanes.

The boiler being installed on the B-25B airplanes has given still better results in comparable laboratory tests with the first two types. This boiler (Fig.17) also is of tubular design,and differs from the other tubular type in that the headers (or horizontal tubes) are outside the tailpipe, as also are all welded joints. Only four vertical tubes remain in direct path of the hot exhaust gases. This boiler is the one which has the heating system drain incorporated on the lower header.

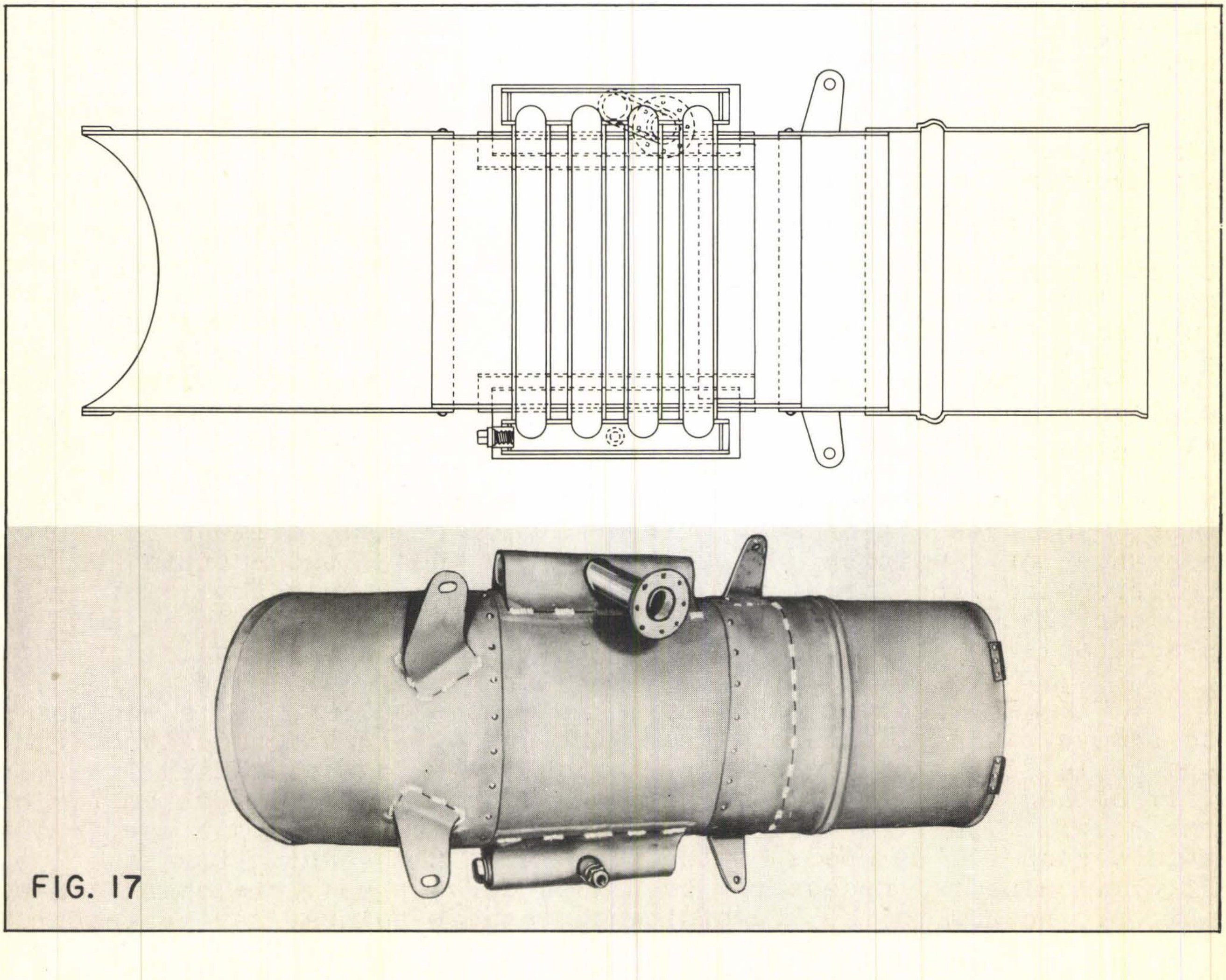


FIG. 17

SERVICING THE VENTILATING SYSTEM

The air after leaving the radiator and mixing chamber, enters the fuselage to a "Y" duct which diverts a portion of the air aft to the radio operator and tail gunner, and the balance forward to the navigator, pilot, and bombardier. This "Y" duct is located at the junctions of the left wing and fuselage. The air diverted aft and that diverted forward is controlled by a semi-permanent splitter valve, located in the "Y" duct, which has been adjusted at the factory to give normal distribution requirements. However, if it is desired to change this distribution, it may be done by removing one screw on the forward face of the "Y" duct and moving the splitter arm "up" to divert more air forward, and down to divert more air aft.

There is also a "tee" duct with a similar splitter as above for diverting some air up to the pilot's air outlet and windshield de-frosting duct, and some forward to the bombardier's outlet, bomb sight window de-frosting duct and bomb sight de-frosting duct.

This "tee" duct is located at the left side of ship at the entrance of the passageway to the bombardier's compartment. Moving this splitter arm down will divert more air forward, and moving it up will divert more air to the pilot's duct.

This valve has also been set at the factory for normal distribution and may be changed by removing one screw.

MAINTENANCE AND REPAIR OF HEATING SYSTEM

A. Steam Boiler:

(1) General: The steam boiler for the heating system is located within the tailpipe (Fig.17) of the left engine exhaust manifold and, by virtue of its being exposed to the full blast of the engine exhaust, becomes red hot during operation of the engine. When water is allowed into the boiler, a very high temperature differential is produced which, under certain conditions, may cause the boiler to crack at the welds or at other points of stress concentration. The presence of such failures will be made evident by the appearance of a whitish chemical or oxide upon the surface of the boiler, about the interior of the tailpipe or upon the surface of the nacelle. Failures of this type should be repaired as soon as practicable in accordance with the following instructions.

(2) Removal of Boiler: To remove boiler, it is necessary to remove tailpipe assembly from airplane by first freeing the inlet and outlet lines at the boiler, and then the four attaching lugs. It will be necessary to remove the access door located in the bottom of the nacelle, just forward of the main landing gear, in order to obtain access to the heads of the two aft bolts securing the tailpipe. It will also be necessary to use an off-set box wrench at these points. Access to the remaining disconnect points may be acquired

by removing the side and lower dzus-fastened panels, located just above and just below the tailpipe, respectively. When disconnecting the outlet from the boiler, exercise particular care not to damage the flexible connecting line when removing the screws from the flange adjacent. An off-set wrench will be required at the connection of the inlet line.

(3) Disassembly: After the assembly has been thus removed from the airplane, detach one or the other of the short tailpipe extensions from the outer shell of the boiler assembly by drilling the attaching rivets. It is worthy of note that these rivets are of Monel metal and that the process of drilling them will be comparable to that of drilling steel.

(4) Repair: If the leak is small, its location may be ascertained by means of air pressure. After the leak has been located, clean the area adjacent thoroughly and weld a substantial bead over the leak. Refer to T.O. No. 23-5-3. Material conforms to Spec. No. 57-136-9. The weld should be made by means of oxyacetylene only and must penetrate deeply. Fuse or dress the bead until sharp corners are entirely removed and weld it as flat as possible; this is to prevent exhaust gases from burning the weld away. Large cracks or leaks may be repaired by welding a suitable reinforcement over the damage. If necessary for accessibility to leaks, the tailpipe section around the boiler may be separated, and folded away from the affected area. It can then be replaced and acetylene welded to its former position.

As a test measure after repairing, plug the outlet opening and apply an air pressure of 80 pounds per square inch to the inlet opening. Immerse the boiler in water for several minutes and watch for bubbles. Do not use oil for such purposes.

(5) Reassembly and Installation: Use Monel rivets for reassembly of the tailpipe extension to the boiler assembly. In order to prevent the blast of the exhaust from burning the rivets away, it is essential that the original heads of rivets be placed on the inner side of the assembly.

Prior to reconnecting the inlet lines, apply a thin mixture of white lead to the threads. This practice is not, however, a necessity, merely a recommendation.

B. Steam Radiator:

(1) General: The steam radiator for the heating system is located in the left side center wing leading edge.

Unless precautions as mentioned before are observed, freezing may occur in this unit (Fig. 18) with resulting possibility of leaks.

(2) Removal of Radiator: Access for removal of radiator may be obtained from a door in the upper surface of the left center

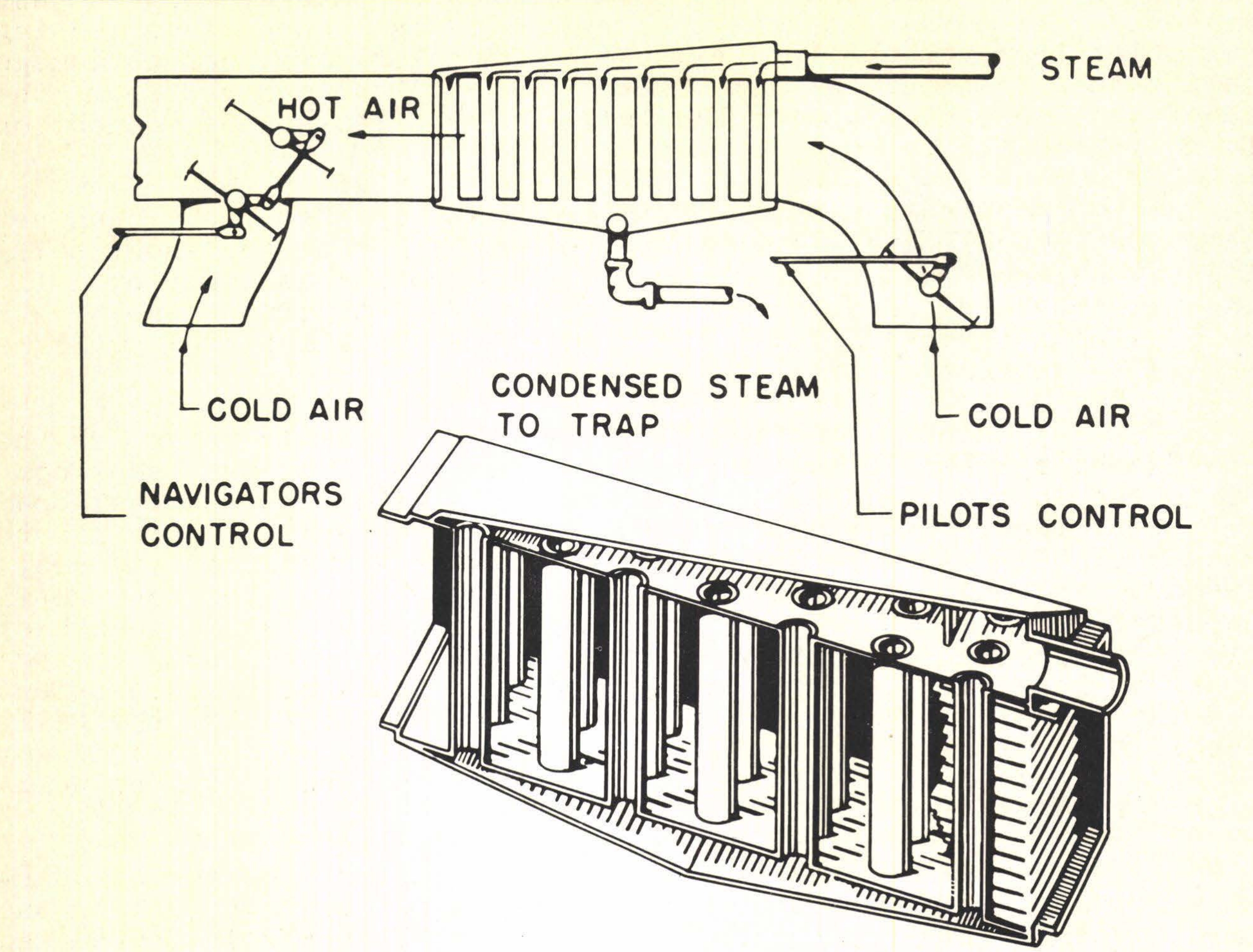


FIG. 18 STEAM RADIATOR

wing leading edge.

A Phillips head screw driver will be required to remove the door. The radiator is mounted between two ducts by means of retaining clamps at each end. First disconnect the steam inlet hose connection at the upper outboard end of the radiator and condensate line at the lower forward side. Also remove the air vent valve mounted on the forward side. Remove two bolts at each clamp and lift the radiator upward.

(3) Disassembly: After assembly has been removed from airplane and leak apparently is not adjacent to either end, remove the insulation material, and the side panels. The side panels are attached by copper rivets. Care should be taken in drilling these rivets not to drill through into the radiator headers.

(4) Repair: The leak may be determined, if hidden, by applying air pressure and immersing in water. If the leaks are at the end of a tube, access may be obtained by opening the header at a point opposite that tube. After the leak has been repaired, a

patch may be applied over the opening.

The material of this unit is copper sheet and copper tubing. The fins and side plates are aluminum alloy. All brazed joints are copper to copper; the brazing material used is "Sil-fos". The repair should be made by use of "Sil-fos" but according to the radiator manufacturer, silver solder gives a satisfactory repair job. After repairing, the unit shall be tested to a pressure of 30 pounds per square inch air pressure. Immerse the unit in water and watch for bubbles.

(5) Reassembly and Installation: Copper rivets or soft aluminum rivets may be used for reassembly of side plates. All adjoining surfaces of copper and aluminum should be well coated with zinc chromate primer before assembly. The insulation may be replaced and attached by doping of fabric cover.

Prior to reconnecting the condensate line, apply a thin mixture of white lead to the threads. This is not a necessity, however.

C. Water Reservoir:

(1) General: This unit is located in the left rear corner of the navigator's compartment.

Freezing of water in the reservoir may cause leakage or severe rupture. This will be readily noticed by leakage of water or steam into the navigator's compartment.

(2) Removal of Reservoir: The assembly may be removed by first removing the protecting shield around the reservoir.

Secondly, disconnect the vent line, and overflow line, between the reservoir, and the fuselage skin; and also the water outlet line at the steam shut-off valve. Then, remove three bolts, two at the bottom and one at the top.

(3) Disassembly: The reservoir assembly is a weld assembly except for the attached water gauge, safety valve, and shut-off valve. In repairing, first remove water gauge glass to prevent breakage.

(4) Repair: The leak may be ascertained by means of air pressure. The material is aluminum alloy and can be welded. As a test measure the reservoir shall be tested to 30 pounds per square inch after repair.

(5) Reassembly and Installation: All threaded joints may be white leaded but it is not a necessity.

In reassembling the glass into the water gauge, rotate so that red line is in back, giving a red appearance to water in glass when facing the reservoir from the normal position.

D. Condensate Trap:

(1) General: This unit is located on the forward left side of the left firewall. It is a brass casting and contains a brass ball float which operates a small valve, permitting water to pass when the float is raised.

This unit is subject to deposits of grime and sediment, since the orifice opening is small. It should be inspected at regular intervals.

(2) Removal: The condensate trap may be removed by removing three water line hose connections and three retaining bolts.

However, in most cases satisfactory cleaning and repair may be accomplished by just removing the condensate trap cover and the drain plug in bottom of the trap.

(3) Disassembly: The condensate trap may be disassembled by removing the five cap screws attaching the cover; remove the cotter pin retaining screw and cotter pin,and remove the float ball.

(4) Repair: A leak in the float ball may be repaired by silver solder. It is a brass part.

(5) Reassembly and Installation: Be certain that the cotter pin retaining screw is safetied before reassembling the trap cover-plate, to assure no sticking of float ball.

E. Air Vent Valves:

(1) General: This part is a standard thermostatic air vent. A thermostatic bellows expands when hot--closing a needle valve, thereby preventing leakage of steam or hot water.

(2) Repair: This is a sealed unit and may only be cleaned by rinsing thoroughly or blowing out with air pressure. Use caution with air pressure.

TROUBLE SHOOTING STEAM-HEATING SYSTEM

(1) If in flight and the heating system stops functioning:

(a) This may happen shortly after take-off,in which case check the steam valve. The water may still be in the reservoir, or if part of the water had been added at the boiler, that part has evaporated.

To let the water down into the boiler now, will be quite a shock; the boiler may be red hot and might be cracked due to this quenching.

It would be better to wait until power has been reduced

somewhat and exhaust gases are cooler and then open valve slowly. There may be surging back and forth for a while until the system stabilizes.

(b) If the heating system has been operating for sometime, first see that the reservoir still contains water; be sure valves of water gauge are open. Second, check outside air temperature; freezing may have started due to excessive air flow. Close radiator air inlet shutter; attempt to regain circulation. Third, a line may have been broken.

(2) If heating system starts O. K. on ground but seems to run cold in air:

(a) Navigator should check his "hot" and "cold" air control to see that it is in the "hot" position.

It is important that this control be properly rigged at all times, as a very small amount of extremely cold air will affect the resulting mixture temperature considerably.

The valve in the cold air inlet duct in the wing leading edge next to the fuselage must always be straight across position, when the "hot" and "cold" air control is in the "hot" position.

(b) Check pilot's radiator air inlet shutter control. It may be still closed, or if open it possibly should be partially closed to reduce air flow.

(c) Check steam valve on bottom of water reservoir; is it open?

(3) If heating system fails to start on ground:

(a) See that water has been added to system and that at least part of it is in the boiler.

(b) If circulation refuses to start, with all the water down, drain out some water and try again with a smaller quantity in the boiler.

The system may be air-bound due to malfunctioning of the air vent valves, and using a smaller quantity of water in the system will permit steam to force the air out through the reservoir vent more readily.

The air vent valves should be cleaned or preferably replaced.

(c) A line may be frozen in some part of the system. If the water reservoir in the cabin is hot, and the air leaving the ducts is cold, the steam line from the boiler to the radiator or the radiator itself may be frozen, or the condensate line from the radiator may be frozen.

If the water reservoir is cold, the water line from the reservoir may be frozen.

(4) The most likely places for leaks:

(a) Boiler, at welded joints.

(b) Hose connections on large steam line, one at wing nacelle joint and one at radiator.

(c) Safety valves may be stuck open by scale.

(d) Air vent valves.

To check system for leaks, cover holes in top of each of two air vent valves with masking tape or similar material, disconnect vent line in top of water reservoir in navigator's compartment, and apply air pressure here. Listen for leaks.

NORTH AMERICAN AVIATION Inc.

De-icer System LECTURE

B-25 SERIES AIRPLANES

PREPARED BY *J. C. Anstrom*

NOTE

THE INFORMATION CONTAINED IN THIS LECTURE WAS CORRECT AS OF JANUARY 1, 1942. REFER TO HANDBOOK OF OPERATION AND SERVICE INSTRUCTIONS FOR THE LATEST INFORMATION.

N A A

INGLEWOOD, CALIFORNIA

I N D E X

I L L U S T R A T I O N S

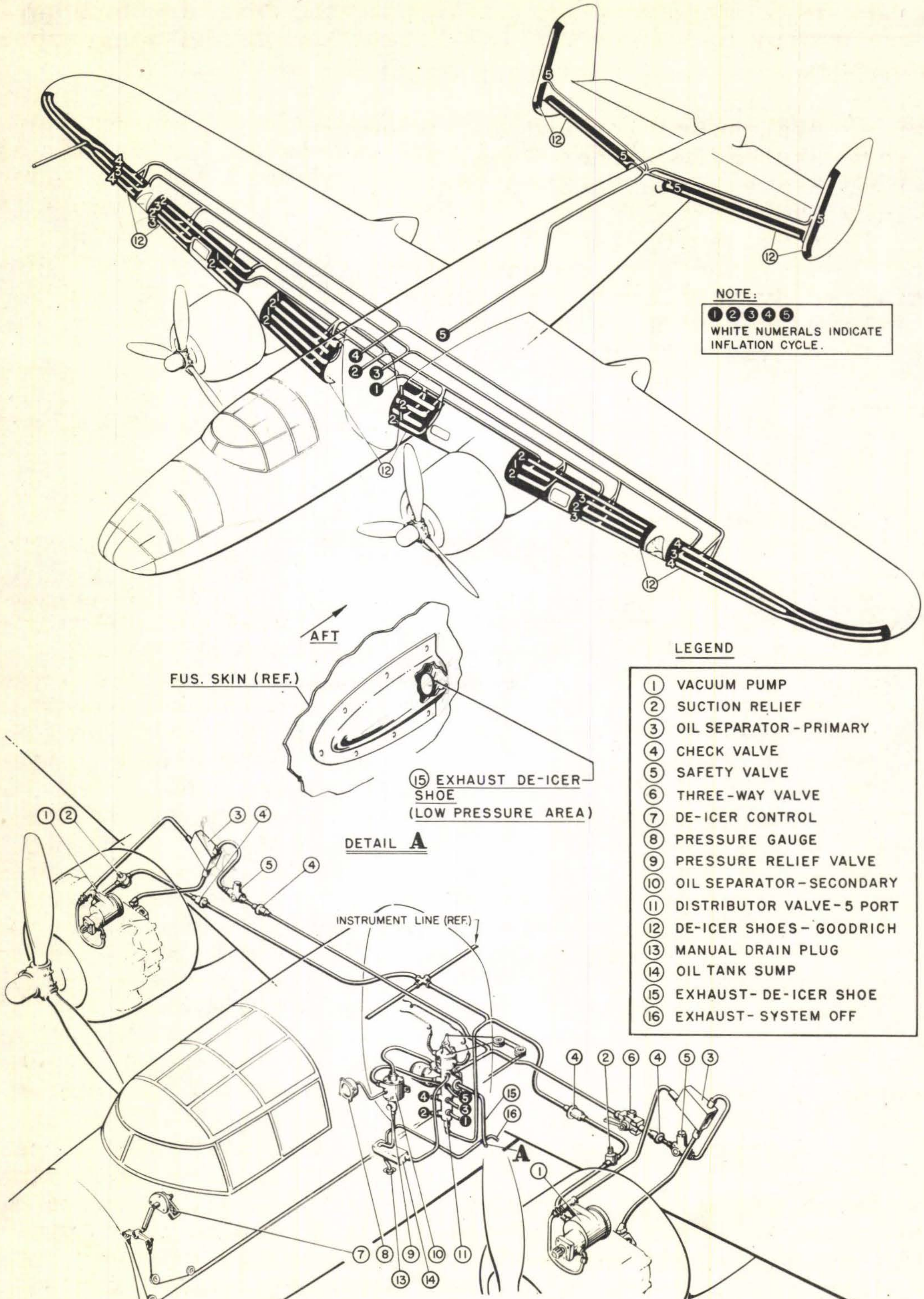


FIG. 1 DE-ICER SYSTEM DIAGRAM

GENERAL DE-ICER AND ANTI-ICER SYSTEMS

On the B-25 airplanes the conventional de-icer and anti-icer systems are employed to prevent ice formation on the wing, empennage, and propellers.

The de-icer system consists of inflatable rubber de-icer shoes on the leading edges of the wing and empennage, inflated by two vacuum pumps. A single, surface de-icer control handle, accessible to the pilot, controls the de-icer system. A pressure gauge for the system is located in the rear of the navigator's compartment. When the de-icer system is not in operation, vacuum pump suction is employed to prevent the negative air pressure, during flight, from raising the de-icer shoe cells.

The anti-icer system consists of anti-icing the propellers with anti-icer fluid. The anti-icer fluid is supplied to the propeller slinger rings by an electrically-driven pump controlled by a rheostat, accessible to the pilot.

DE-ICER SYSTEM OPERATION

Operation of the surface de-icer system is automatic upon operation of the surface de-icer control (7), located on the left-hand side of the pilot's instrument panel, accessible to the pilot. When the control is turned "ON" the de-icer distributor valve (11) is operated by means of bellcrank and cable controls running along the left side of the fuselage between the two units. The de-icer distributor valve is located in the rear of the navigator's compartment and is attached by bolting to the fuselage bulkhead. The de-icer distributor valve contains a four-way valve, electrical switch, electric motor (to be discussed during the electrical lecture) and a rotary distributor valve. The function of the de-icer distributor valve in the "ON" position is to close the electrical switch starting the motor, which operates the rotary valve of the unit and directs the air supply of the system from the vacuum pumps to the de-icer shoes. The vacuum pumps (1) (to be discussed during the instrument lecture) located on each of the two engines, furnish the pressure air supply for the de-icer system from the outlet side of the pumps. The air from the vacuum pumps is directed by tubing to the primary oil separators (3), which are bolted to engine mount cross tubes in each of the two engine nacelles. The function of the primary oil separator is to remove atomized particles of oil from the de-icer system air supply. From the primary oil separators the air is directed by tubing to safety relief valve (5) bolted to engine mount cross tubes in each of the two engine nacelles. The function of the safety relief valves is to relieve any pressure in excess of 10 lb./ sq.in., maximum operating pressure, which may be caused by malfunctioning of the de-icer system. These safety valves are a protection for de-icer shoe cells and eliminate the possibility of over loading and heating the vacuum pumps. The air is then directed through check valves (4) located in the de-icer system lines, and supported by the lines only, in each of the two engines nacelles.

The function of the check valves is to prevent reverse flow of air in the event one engine should cease to operate, and also to eliminate the bleeding of an outside source of air supply which may be connected into the system between the check valves. The air leaving the check valve in the left-hand engine nacelle passes through a three-way plug valve (6), which is mounted on the engine mount cross tube in the left-hand engine nacelle only. The plug valve is provided as a means of connecting an outside source of air supply for a ground check of the de-icer system when the engines are not running. The plug valve has a control handle for turning the outside source of air supply "OFF" or "ON". The air from both air supplies is then directed through a tubing (Y) to a single line through the distributor four-way valve to the secondary oil separator (10).The secondary oil separator is bolted to a bulkhead in the rear of the navigator's compartment, next to the de-icer distributor valve. The secondary oil separator removes any condensed particles of oil that may be in the air supply and regulates the air pressure to seven and one-half (7-1/2) pounds per square inch. The accumulation of oil in the secondary oil separator is exhausted through the pressure relief valve (9) when the air supply exceeds seven and one-half (7-1/2) pounds per square inch. Due to the de-icer system exhaust (16) being located above the secondary oil separator, which is located in the rear of the navigator's compartment, the de-icer system oil sump (14) was added below the secondary oil separator on the navigator's floor. The primary reason for the oil sump is to eliminate the possibility of exhausting de-icer system oil vapor from the bottom of the fuselage from blowing back to the lower gun turret and obstructing the gunner's vision. The air and oil exhausting from the secondary oil separator passes through a de-icer oil tank sump located below the secondary oil separator. The exhausted air from the de-icer system oil sump tank is exhausted to atmosphere on the left-hand side of the fuselage (16) below the wing. The de-icer system oil sump consists of a tank,which has a three (3) pint capacity, and a manual drain (13) accessible from outside of the fuselage approximately six (6) inches forward of the bomb bay doors in the bottom of the fuselage. The de-icer system oil sump drain may be identified by a stencil on the bottom of the fuselage marked DE-ICER OIL SUMP DRAIN. Connected to the secondary oil separator is the surface de-icer system pressure gauge (8), mounted next to the de-icer distributor valve in the rear of the navigator's compartment. The de-icer system pressure gauge was originally located in the pilot's instrument panel, visible to the pilot. Due to the pilot having no control of the de-icer system operating pressure during flight, and as the gauge is primarily used by the ground service crew,the gauge was moved to the rear of the navigator's compartment as requested by the Air Corps. The de-icer system pressure gauge is marked de-icer pressure and is calibrated from zero (0) to twenty (20) pounds per square inch. The air supply from the secondary oil separator is routed back to the distributor valve where it is directed to one of the five (5) distributor ports and to the de-icer shoe cells (12) in the proper sequence. After inflation of the de-icer shoe cells the air is exhausted back through the distributor valve and overboard to a low pressure area at the de-icer shoe exhaust (15), to insure rapid de-icer shoe cell deflation. The length of time required for one com-

plete cycle of de-icer system operation is approximately forty (40) seconds.

When the surface de-icer control handle is turned to the "OFF" position, the electric switch in the de-icer distributor valve is opened causing the electric distributor valve motor to stop operating. The four-way valve of the distributor is automatically rotated causing the de-icer system air supply to pass through the distributor valve, and thence to the de-icer system oil sump from which it is exhausted (16) to the atmosphere. The "OFF" position of the de-icer distributor valve automatically connects each of the five distributor ports to vacuum pump suction. The applied suction prevents the negative air pressure, caused by wing air foil section during flight, from raising the de-icer shoe cells.

The de-icer system tubing may be identified by the light blue and light green banding which exists on all de-icer lines.

CAUTION: DO NOT operate the de-icer system during take-off or landing. The raised cells of the shoes cause a definite loss in the lift characteristic of the air foil section.

SPECIAL NOTE: The de-icer system should not be operated at speeds above two hundred and forty (240) MPH except in an emergency due to excessive lifting of de-icer shoes from the wing leading edge.

DE-ICER SYSTEM SERVICE AND MAINTENANCE

During engine warm up, with the engines operating at nine hundred and fifty (950) RPM or more, the following check shall be made prior to first flight of each day. The de-icer inflating equipment should be placed in operation and a careful check made to determine whether all of the de-icer shoe cells will properly inflate and deflate. The de-icer shoes should be carefully inspected for punctures, bruises, loose patches, engine oil, etc., and any faulty condition that may be found should be repaired. Cleaning, repairs and service will be made in accordance with Technical Order 03-35B-1. The aforementioned check may be made without the engines running by connecting an outside source of air supply into the system at the three-way plug valve (6). The outside air supply must be clean and must not exceed a pressure of ten (10) pounds per square inch. The system operating pressure of seven and one-half (7-1/2) pounds per square inch shall be regulated by the relief valve (2). To regulate the relief valve, remove the adjusting screw cap, loosen the lock nut, and rotate the screw in a clockwise or counter-clockwise direction until the de-icer pressure gauge reads seven and one-half (7-1/2) pounds per square inch, normal operating pressure. After the correct pressure is obtained, secure adjusting screw lock nut and replace cap. If the de-icer pressure gauge (8) should exceed ten (10) pounds per square inch, maximum operating pressure, immediately shut off the de-icer control and check for the difficulty.

The de-icer system oil sump (14) will require manual draining after every ten (10) hours of engine operation as noted on the de-

icer oil sump name plate, visible from the navigator's compartment. Draining of the de-icer system oil sump tank shall be done by removing lockwire and plug screw (13). After draining tank install plug screw, and secure with lockwire.

NOTE: For maintenance, inspection, installation, removal and storage of de-icer shoes, instructions contained in Air Corps Technical Order 03-35B-1 shall be complied with.

DE-ICER SYSTEM EMERGENCY REPAIRS

In the event any line becomes damaged, that portion of the tube shall be replaced. Service of the de-icer system units shall be made in accordance with Air Corps Technical Orders or service data to be supplied by the manufacturer of the various units.

DE-ICER SYSTEM TROUBLE-SHOOTING

Operation failure of complete system:

1. Check control cable to distributor valve.
2. Check air supply (this may be done by disconnecting line hose to trace last point of air supply).
3. Repair of faulty unit or lines.

Operation failure of one de-icer shoe cell:

1. Check de-icer shoe back connector for security.
2. Check air supply lines from distributor to back connector of de-icer shoe cell.
3. Check distributor valve for stoppage.

DE-ICER SHOE INSTALLATION

(Reference North American Aviation, Inc., De-Icer Installation drawings.)

Prior to installing de-icer shoes on the wings, it is necessary to remove rubber plugs from air line holes in the leading edge of the wing, and to remove access doors as required to gain access to de-icer line fittings. Prior to installing de-icer shoes on empennage, it will be necessary to remove cover-plates from horizontal stabilizer leading edge and plugs from vertical stabilizer de-icer line holes. Remove tape from all de-icer line fittings, and remove rivnut plug screws. The respective de-icer shoes and fairing strips (shown on N.A.A. drawing 62-53090) should then be punched and drilled. In punching the rubber de-icer shoes, care must be taken to stretch the middle, or tube zone, lengthwise to cause metal bead in edge of shoes to lie flat. Allowance must also be made for "END PULL UP" or longitudinal contraction of the shoes in the installed position, in order to prevent shoes from pulling loose. Care should be taken in punching to keep the holes exactly at edge of metal bead.

During all handling operations, care should be exercised not to damage the rubber. It is necessary to jig drill and counter-sink the fairing strips for No. 6-32 flat head screws. Attach Goodrich non-kink de-icer hose to lines with brass safety wire; for length of non-kink hose and proper locations for each hose see N.A.A. drawing 62-53090 (these hoses are to permit attachment to connector fittings in de-icer shoes). To install de-icer shoes on wing, temporarily insert No. 6-32 one and one-fourth (1-1/4) inch headless bolts in rivnuts at intervals of three (3) or four (4) feet on upper surface of wing leading edge. The shoes should then be slipped on the studs. Place the correct fairing strip over studs and insert one-half (1/2) inch No. 6-32 cadmium-plated, flat head, machine screws in the remaining holes between the studs. Tighten screws only enough to hold the shoe in place. Replace temporary studs with flat head machine screws. Fold rubber back over wing and thoroughly dust inside of shoes with talcum powder, specification 4-33; connect non-kink air supply lines to their respective connecting fittings on de-icer shoes, and secure with brass safety wire. To attach de-icer shoes to lower surface of wing, it is necessary to insert a temporary stud in every other rivnut, due to the tension of the shoe in the installed position. The shoe should then be attached, using one man to pull the rubber down over the entering edge with his open hands against the surface of the rubber, a second man to grasp the bead and hook it over the studs and flat against the wing skin. Place the fairing strip over the studs, insert the screws in the intervening rivnuts, and replace temporary studs with screws. Tighten the screws to embed front edge of fairing strip in the rubber. The tension of the shoes prevents the screws from loosening, therefore, excessive tightening is not necessary. If the trailing edge of the fairing strip is flat against the wing surface, chafing of the wing skin should not occur. However, as a safeguard, a strip of common masking tape can be placed on the wing skin under the trailing edge of the fairing strip. When the fairing strip is omitted, the de-icer shoes may be attached by utilizing one-half (1/2) inch washers under screw heads. To install the de-icer shoes on the leading edge of the stabilizers, follow the same general procedure just outlined. After complete installation of the de-icer shoes, the system should be operated as a final check of the installation.

ANTI-ICER SYSTEM OPERATION

Operation of the propeller anti-icer system is automatic upon operation of the anti-icer control rheostat (7), located in the pilot's main switch panel, marked "PROPELLER ANTI-ICER", which is accessible to the pilot. The anti-icer rheostat is clearly marked "ON" and "OFF". To supply anti-icer fluid to the propellers, turn the rheostat control to the extreme "ON" position for thirty (30) seconds, then turn the rheostat toward the "OFF" position, until the desired output is obtained. The anti-icer rheostat controls the operation of the anti-icer fluid pump (6) by being electrically connected. The anti-icer fluid pump consists of a gear type pump, one inlet port from the anti-icer supply tank, two outlet ports, one to each of the two propellers, and an integral electric motor re-

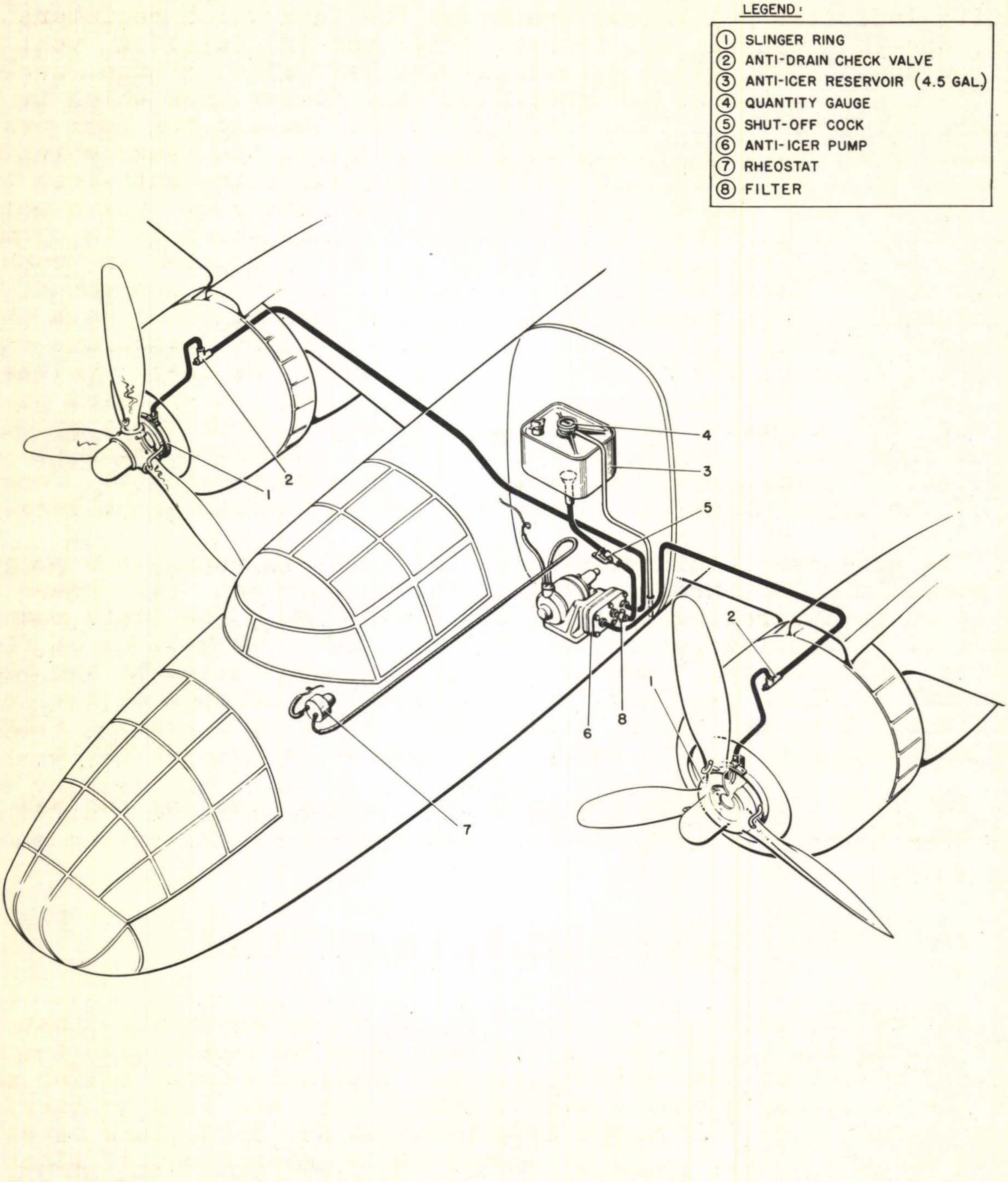


FIG. 2 ANTI-ICER SYSTEM DIAGRAM

ceiving its energy from the airplane's main electrical supply. The anti-icer fluid pump is bolted to the floor in the rear of the navigator's compartment, aft of the escape hatch. The pump receives the fluid from the anti-icer supply tank (3) which is clamped to a shelf under the navigator's riding seat chart table. The anti-icer fluid tank has a capacity of four and one-half (4-1/2) gallons, with a quantity indicator (4) in the center of the tank which registers (E) empty, one-third (1/3), two-thirds (2/3) and (F) full. A vent and overflow drain line, which extends to the left side of the fuselage near the bomb bay doors, is provided at the filler neck which is the standard Air Corps type. The anti-icer fluid leaving the tank passes through a plug valve (5), located directly below the tank, which may be used to shut off the fluid supply in the event the anti-icer tank is to be removed. The anti-icer fluid from the plug valve passes through the fluid filter (8) to the pump from which it is pumped through the anti-icer lines to check valves (2) located in each of the two engine nacelles. The check valves are set to operate at one and one-half (1-1/2) pounds per square inch and function as a check to prevent gravity flow of the fluid in airplane positions other than level flight. The fluid passing through the check valves is then directed to the anti-icer feed line connection located on the bottom of the propeller slinger ring assembly. From the stationary slinger ring nozzle the fluid passes into the slinger ring (1) attached to the propellers, from which it is directed to the forward face of the three propeller blades of each of the two propellers.

The anti-icer fluid supply is sufficient to supply the propellers with fluid for three-fourths (3/4) to thirteen (13) hours depending on the operating speed of the fluid pump. The fluid pump is capable of delivering two-thirds (2/3) to six (6) gallons of fluid per hour, which is regulated by the rheostat controlled by the pilot. The amount of fluid required for the propellers depends on the icing conditions. The anti-icer fluid tank is fillable during flight, which makes it possible to carry an additional supply of fluid.

The anti-icer system tubing may be identified by the red and white banding which exists on all anti-icer lines.

ANTI-ICER SYSTEM SERVICE AND MAINTENANCE

Before filling the anti-icer fluid tank, ascertain that the handle of the shut-off valve in the feed line is safetied in the open upward position. To gain access to the fluid tank filler cap, raise the navigator's riding seat chart table and fill to overflow with anti-icer fluid Air Corps specification No. 3585. Tank capacity is four and one-half (4-1/2) gallons. Check operation of float on quantity indicator and dial pointer for full position. When reservoir is filled replace cap securely. Check operation of anti-icer outlet line check valves for proper operation by turning pump on momentarily to check delivery of fluid to both propeller slinger rings.

ANTI-ICER SYSTEM CHECK AFTER OPERATION

After each flight in which the propeller anti-icer system has been used the propeller hub and slinger ring shall be washed down and all traces of solution removed. Inspect slinger rings for any dripping of anti-icer fluid, and if any occurs, it will be necessary to inspect the outlet line check valve for malfunctioning.

ANTI-ICER SYSTEM EMERGENCY REPAIRS

In the event any line becomes damaged, that portion of the tube shall be replaced. Service of the anti-icer system units shall be made in accordance with Air Corps Technical Orders or service data, to be supplied by the manufacturer of the various units

ANTI-ICER SYSTEM TROUBLE-SHOOTING

Operation failure of the complete system:

1. Check electrical supply to anti-icer fluid pump.
2. Check anti-icer fluid supply to pump; this may be done by removing line fittings.
3. Check the last point of fluid supply between anti-icer fluid metering pump and slinger rings on propellers.
4. Replace the faulty equipment, or repair as previously mentioned.

NOTE:

1. Whenever complete airplane is to be stored the instructions contained in Technical Order 01-1-7 shall be complied with.
2. Slinger ring installation and removal shall be made in accordance with Technical Order 03-20CC-2.

ADDENDUM I

NOTE:

1. The de-icer system exhaust on B-25 and B-25A airplanes emerges at the bottom of the fuselage. The system on these models exhausts directly from the secondary oil separator and have no oil sump as do the B-25B and later models.

2. Airplanes prior to the sixty-third (63rd) B-25C airplane have a propeller slinger ring assembly which has an anti-icer feed line connection located on the top of the propeller slinger ring assembly. Propeller anti-icer feed lines connecting to the slinger ring assembly will not be interchangeable from airplanes prior to the sixty-third (63rd) B-25C to those of the sixty-third (63rd) B-25C and subsequent.

3. On the B-25, B-25A and B-25B airplanes the anti-icer fluid supply is sufficient to supply the propellers with fluid for one and one-half (1-1/2) to twenty-six (26) hours depending on the operating speed of the anti-icer pump. This difference is due to the twelve (12) volt electrical system on these airplanes and a twenty-four (24) volt system on the B-25C and B-25D airplanes.

ENGINE PERFORMANCE

NORTH AMERICAN AVIATION Inc.

Engine Performance LECTURE

B-25 SERIES AIRPLANES

PREPARED BY Roy W. Ferren

NOTE

THE INFORMATION CONTAINED IN THIS LECTURE WAS CORRECT AS OF MAY 15, 1942. REFER TO HANDBOOK OF OPERATION AND SERVICE INSTRUCTIONS FOR THE LATEST INFORMATION.

THIS DOCUMENT CONTAINS INFORMATION AFFECTING THE NATIONAL DEFENSE OF THE UNITED STATES WITHIN THE MEANING OF THE ESPIONAGE ACT, 50 U.S.C., 31 AND 32. ITS TRANSMISSION OR THE REVELATION OF ITS CONTENTS IN ANY MANNER TO AN UNAUTHORIZED PERSON IS PROHIBITED BY LAW.

N A A

INGLEWOOD, CALIFORNIA

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ILLUSTRATIONS

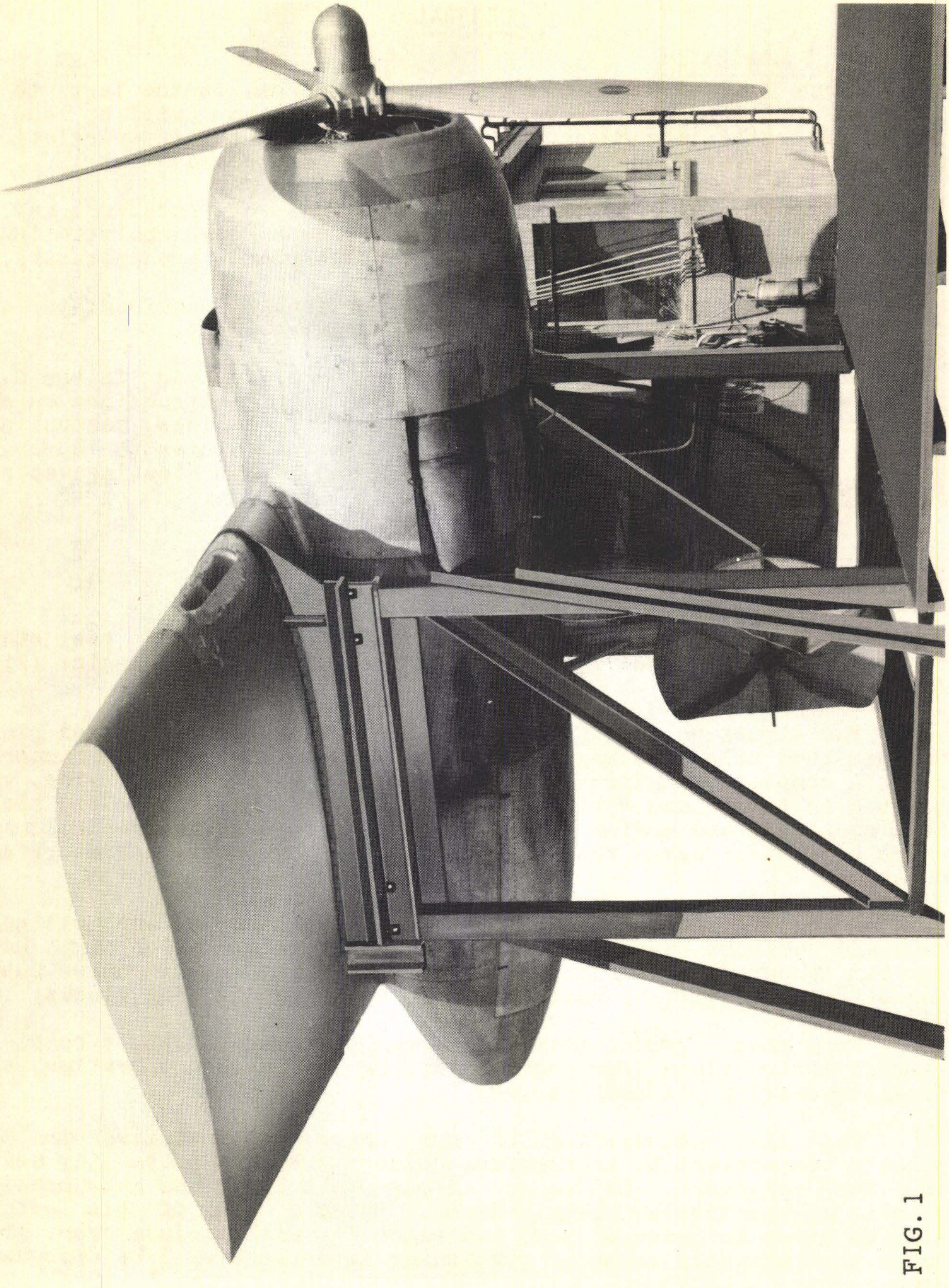


FIG. 1

GENERAL

Since this lecture on Engine Performance is the last to be given on the subject of Power Plants, an endeavor will be made to include a rather broad scope in order to show the inter-relationship of the Power Plant subjects previously discussed.

Although many instructions and methods of procedure may be obtained directly from A. C. Technical Orders, some modifications, which are peculiar to the B-25C and B-25D Airplanes are necessary.

It is with these modifications, particular requirements and innovations, that we are especially concerned.

Various lists, charts, tabulations, etc., appear in the B-25 series Airplane handbook showing step-for-step instructions on engine starting and ground operation, power limitations, control operation, special instructions, precautionary measures to observe, etc. Considerable time ground testing and flight testing was required to obtain this information.

GROUND TESTING

A complete power plant was installed on a special test stand of our design for the purpose of ground testing the engine (Fig. 1).

The structure itself is made of steel sections. A wood platform is laid below the engine for use in supporting working ladders, etc. A complete engine nacelle, together with a wood wing, was mounted in the ground attitude condition. All temperature and pressure equipment and engine controls were led to a master control house where sufficient space was provided for the necessary operators and observers.

A complete pattern of temperatures was taken of each cylinder head and cylinder base as well as any other points which might have maximum temperature limitations, such as engine mount rubber bushings, fuel and oil temperatures, magneto, and spark plug elbows.

From these ground tests and from our flight tests a complete list of instructions for engine starting and ground operation, and flight operation has been derived.

This list, consisting of four pages, is installed in the pilot's compartment in transparent holders where it is readily available for reference. Let us go through this list and make special note of any particular requirements. Since a copy of this lecture will be given to each of you, and since it will include every item to be checked, only those of particular importance will be discussed here.

STARTING AND GROUND OPERATION

NOTE: An explanatory note for steps marked with quotation marks follows this list. (See Pages 9 to 15).

" 1. HEAD AIRPLANE INTO THE WIND.

2. Nose Gear Towing Pin ENGAGED.

3. Emergency Nose Gear Operating Pawl Control "OFF".

4. Main Gear Flap and Bomb Door Emergency Controls Stowed.

5. Check Emergency Brake Air Pressure - 550 - 600 lb.

" 6. Both Emergency Escape Hatches "UNLOCKED".

7. Check ignition switches "OFF" and set Parking Brakes.

8. UNLOCK FLYING CONTROLS AND CHECK OPERATION.

9. REMOVE AND STOW LOCKS ON HYDRAULIC CONTROLS.

10. If inoperative for 2 hours, turn Propeller by Hand 3-4 Rev. (Ignition "OFF").

11. Open throttle 1/2 inch (700-800 RPM).

12. Propeller full "INCREASE RPM".

"13. Mixture - "FULL RICH".

"14. Supercharger - "LOW" (Locked).

15. Oil Cooler Shutters - "CLOSED".

"16. Carburetor Air - "NORMAL".

"17. Cowl Flaps - "OPEN".

18. Check Emergency Fuel Shut-Off Valves "ON".

19. Switch "ON" Battery Disconnect, Generator, Ignition Safety, Ignition, and Active Inverter Switches.

20. Booster Pump "ON" (Fuel Pressure 6-7 lbs.).

21. Prime 3-5 seconds if Cold; 2 seconds if Hot.

22. Starter Energizing Switch "ON". (30 sec. Minimum, then engaging Switch "ON". If engine fails to start due to cold, use Hand Crank to fully energize, then engaging followed by energizing switches "ON"; hold both "ON". (Use portable energizer when available).

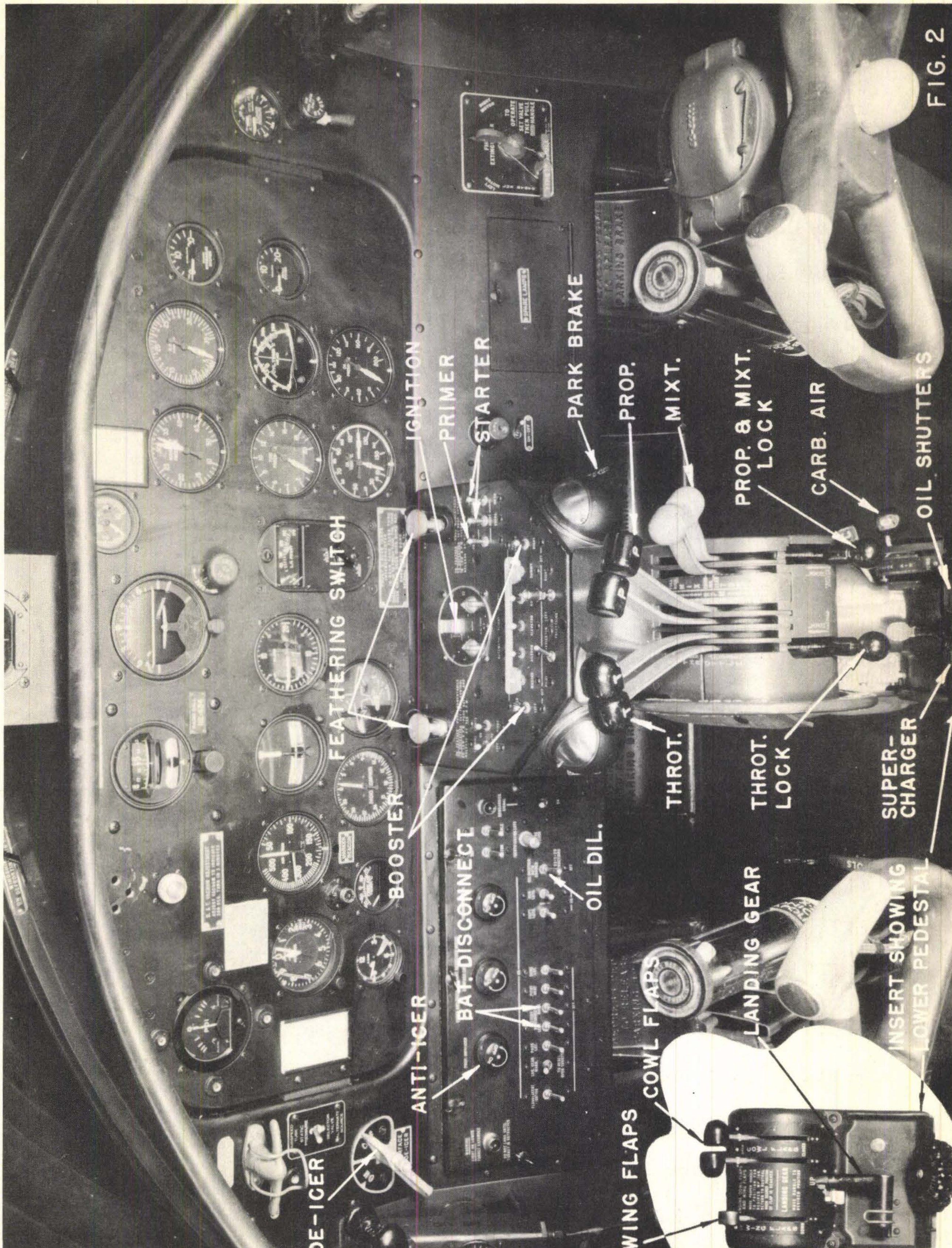

IGNITION
PRIMER
STARTER
PARK BRAKE
PROP.
MIXT.
PROP. & MIXT. LOCK
CARB. AIR
OIL SHUTTERS
FEATHERING SWITCH
BOOSTER
THROT.
THROT. LOCK
SUPER-CHARGER
OIL DIL.
BAT. DISCONNECT
ANTI-ICER
LANDING GEAR
COWL FLAPS
INSERT SHOWING LOWER PEDESTAL
WING FLAPS
DE-ICER
PARKING BRAKE

FIG. 2

23. PRIME WHILE ENGAGING AS REQUIRED.

24. As engine starts, check Oil Pressure. If not 40 lbs. after 30 seconds, stop engine and investigate. WARM engine at 1200 RPM until Oil Temperature shows a definite increase and oil pressure remains steady when throttle is opened.

"25. Booster Pump "OFF" (Fuel Pressure 6-7 lbs.)

26. Open Oil Cooler Shutters at oil temperature of 40°.

27. Check ELEVATOR, AILERON and RUDDER TRIM.

28. Check Propeller Control and Flap operation.

29. Check L and R Magnetos at 1800-2000 RPM; Maximum Manifold Pressure 27-31.5 inches Mercury (Max. RPM Drop 75). If greater, run at same RPM for 15 seconds and recheck.

30. Check all fuel levels.

"31. At 1600 RPM Check Volts, 28-28.5; Amps., 40-60 max.; and Suction, 3.75 to 4.25.

NOTE: THESE CHECK-OFF LISTS ARE APPLICABLE FOR NORMAL OPERATING CONDITIONS. FOR OTHER CONDITIONS, INCLUDING PREFLIGHT AND AFTER FLIGHT INSPECTION, REFER TO T. O. 01-60GB-1 and -2.

PILOT'S CHECK-OFF LIST

BEFORE TAKE-OFF (TAXI)

1. Nose Gear Towing Pin Engaged (Cap on). Note position of nose wheel.

2. CHECK FLYING CONTROL FOR FREE AND PROPER MOVEMENT. (Look at them.)

3. De-icer Control "OFF".

4. Hatches Closed and Lower Turret Retracted.

5. Check Fuel Levels.

6. Suction 3.75 to 4.25.

7. General Hydraulic Pressure 800 - 1100.

8. Brake Pressure 1000 - 1200.

9. Fuel Booster Pumps Both "ON" (Fuel Pressure 6-7 lbs.).

10. Check ELEVATOR, AILERON and RUDDER TRIM.

11. Propeller Full "INCREASE RPM" (Locked Snug).

12. Mixture Full "RICH" (Locked Snug).

13. Supercharger "LOW" (Locked).

14. Oil Cooler Shutters "OPEN".

15. Carb. Air "NORMAL" or "ICING COND." as required.

"16. Wing Flaps 20° Down (Control Neutral) for Best Obstacle Clearance. (30° Down for Short Run).

17. Cowl Flaps "OPEN" (Control Neutral).

18. Emer. Brake Control Safetied.

19. Emer. Hyd. Selector Valve "NORMAL".

20. Check Emergency Fuel Shut-off Valves "ON".

21. Heater "OFF".

22. Uncage Gyro Instruments.

TAKE-OFF

WARNING: DO NOT TURN ON HEATER DURING TAKE-OFF

1. Propeller Controls "Locked" Snug.

2. Engine RPM 2600 Max. & Man. Press. 44 Max. (1 min.). Lock Throttle Snug.

3. Landing Gear Retracted Only on Definite Signal from Pilot.

4. Fuel Pressure 6-7.

5. Cyl. Temp. 160 Min; 260 Max. for 5 minutes.

6. Oil Pressure 80-90.

7. Oil Temperature 40 Minimum; 95 Maximum.

CLIMBING

1. Landing Gear "UP".

2. Manifold Pressure: 38 Maximum Below 11,000 Ft.
39 Maximum Above 11,000 Ft.

3. Engine RPM - 2400 Maximum.

4. Fuel Pressure 6-7 (Fuel Booster Pumps "ON", as required

to maintain 6-7 lb. fuel pressure.)

5. Cylinder Temp. 260 Max. for 15 Min.

6. Oil Pressure 80-90.

7. Oil Cooler Shutters "OPEN", & Oil Temp. 95° Max.

8. Mixture Full "RICH".

9. Carb. Air "NORMAL" or "ICING COND." as required.

10. Supercharger: "LOW" Below 11,000 Ft.
"HIGH" Above 11,000 Ft.
Shift from LOW to HIGH at 1400 to 2400 RPM.

"11. Wing Flaps "UP"; Cowl Flaps "OPEN" (Controls Neutral).

CRUISING - MAXIMUM

1. Engine RPM 2100 Max., & Manifold Press. 31.5 Max.

2. Fuel Pressure 6-7. (Fuel Booster Pumps "ON" as required to maintain 6-7 fuel pressure).

3. Oil Pressure 80-90.

4. Check Suction 3.75 to 4.25.

5. Mixture Full "RICH".

6. Supercharger: "LOW" below 13,000 Ft.; "HIGH" above 13,000 Ft. Shift from "LOW" to "HIGH" at 1400 to 2400 RPM. (For other cruising conditions see Engine Limits. In prolonged flight in HIGH ratio, shift supercharger as required to remove sludge.

" 7. Adjust Oil Cooler Shutters to 60-86 Oil Temperature.

8. Carb. Air "NORMAL" or "ICING COND." as required.

9. Wing Flaps & Landing Gear "UP" (Flap Control Neutral).

10. Cowl Flaps CLOSED or OPEN as req. (Control Neutral).
Cylinder Temperature 205 Maximum.

11. Check Volts, 28 to 28.5; Amps., 40-60 Max.

LANDING

" 1. De-Icer "OFF".

2. Lower Gun Turret Retracted.

3. Check Fuel Levels.

4. General Hydraulic Pressure 800 - 1100.

5. Brake Pressure 1000 - 1200.

6. Fuel Booster Pumps Both "ON" (Fuel Pressure 6-7 lb.)

7. Propeller - 2100 RPM.

8. Mixture Full "RICH".

9. Supercharger "LOW" (Locked).

10. Oil Cooler Shutters "OPEN".

11. Cowl Flaps "CLOSED" (Control Neutral).

12. Landing Gear "DOWN" & Locked (Below 170 MPH). Check Indicator and Warning Horn.

13. Emergency Brake Control SAFETIED. (Press. 550 - 600 lb.)

14. Heater "OFF".

"15. Flaps "DOWN" (Control Neutral). DO NOT EXCEED 170 MPH. WARNING: IF LANDING IS NOT MADE DO NOT RAISE FLAPS UNTIL SUFFICIENT ALTITUDE AND SPEED ARE OBTAINED.

AFTER LANDING

1. Fuel Booster Pumps "OFF".

2. Propeller at Full "INCREASE RPM".

3. Wing Flaps "UP" (Control Neutral).

4. Cowl Flaps "OPEN" (Controls Neutral).

5. Cage Gyro Instruments.

TO STOP ENGINE

1. Propeller at Full "INCREASE RPM".

" 2. If necessary, use Oil Dilution System.

3. Idle at 600-800 RPM for 1 to 3 min., until Cyl. Temperature is below 190°.

" 4. Run at 1500 - 1600 RPM for 5 seconds, then Move MIXTURE Control to "IDLE CUT-OFF" and at same time open throttle. DO NOT move MIXTURE Control From "IDLE CUT-OFF".

5. After engine stops, Turn "OFF" all switches.

EXPLANATORY NOTES ON STARTING AND GROUND OPERATION

" 1. Important: With the modern, tightly cowled and baffled engine it is impractical to obtain satisfactory ground cooling unless the airplane is headed into the wind. Furthermore, the effect of a crosswind is not necessarily shown in the pilot's instruments; since only one cylinder head temperature is indicated, while any head, base or spark plug elbow may be hot, due to the adverse cooling airflow.

" 6. Prevents accidentally leaving hatches locked, since they are equipped with key locks.

"13. An exception to this procedure should be made in the case of restarting a short time after stopping. Under such circumstances the mixture control should be left in the IDLE CUT-OFF position in which position a charge of fuel is locked in the accelerating pump chamber. Subsequent movement of the mixture control to FULL RICH just after engaging the starter will release this fuel, thereby aiding the start.

In either the FULL RICH or CRUISING LEAN mixture control position the carburetor automatically compensates for altitude changes as well as providing proper fuel flow for all power conditions.

CRUISING LEAN is to be used only under specified cruising conditions, and should never be used when climbing even at low power, since the lean mixtures may cause detonation as a result of the hotter cylinder temperatures which occur in climb.

Since the fuel flow will be metered properly by the carburetor, there is no particular need for either an exhaust gas analyzer or a fuel flow meter on the pilot's instrument panel. These instruments have, therefore, been eliminated in order to simplify the airplane as much as possible.

"14. This engine has a two speed supercharger, or blower, as it is commonly called. This arrangement in effect is the same as having two different types of engines, both for only a slight increase in weight of approximately 15 pounds per engine.

The LOW blower, as it is called, provides sufficient manifold pressure for take-off power and for maximum power operation at low altitudes (below 11,000 feet) where only a small amount of supercharging is required.

When maximum performance operation is required above 11,000 feet, the blower should be changed into "HIGH", under which conditions the blower speed is appreciably increased, with a result of increasing the available manifold pressure. Consequently, the engine will be able to develop maximum power to an even higher altitude. In this condition, maximum power may be obtained as high as 15,000 feet altitude.

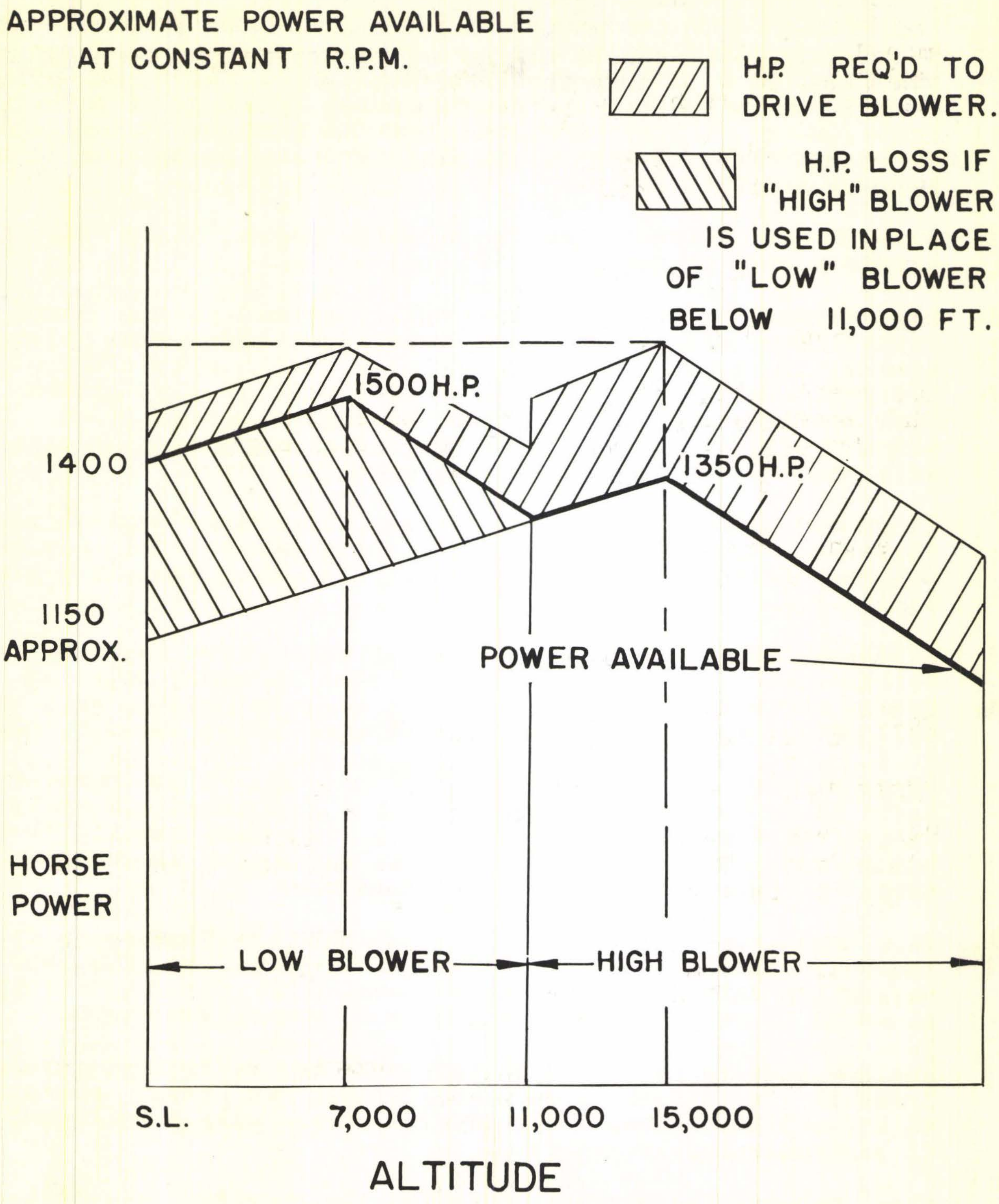


FIG. 3 HORSEPOWER CHART

In effect, then, the engine is capable of maximum power output for take-off and for all altitudes up to 15,000 feet.

Since considerably less engine horsepower is required to turn the "LOW" blower than the "HIGH" blower speed, this difference in horsepower may be used as useful power.

To clarify these comments, a typical power chart, Fig. 3, has been prepared to show the available engine horsepower at various altitudes.

If the blower is not in "LOW" during take-off, there will be a large horsepower loss for a given manifold pressure, and there is also a possibility of detonation due to the high mixture temperature resulting from passing through the rapidly rotating blower.

When shifting from one blower ratio to another, the change should be made quickly, without pausing in neutral, in order to reduce the clutch slippage to a minimum.

It is always more economical to cruise in "LOW" blower, since less power is required to drive the blower. However, due to weather conditions or other causes, extremely high altitude flying necessitating "HIGH" blower may be required.

"16. Since the type of carburetor installed is not likely to ice up the venturis, there is no special need for a large hot air source. There is, however, a need of providing an alternate and protecting source of air inlet to the carburetor in order that sleet, ice or hail particles cannot enter and close or damage the carburetor.

It has, therefore, become the policy to incorporate only two positions on the heat control rather than a number of notches as in the past.

The "NORMAL" position allows air to enter the carburetor from the scoop in the customary fashion. This position is to be used during all normal operation.

Whenever rain, snow, sleet, or visual wing icing conditions are present, the control should be set at "ICING CONDITIONS". In this position the airscoop entrance is closed off and a door is opened below the engine cowling and behind the cylinders, where ice-free air may be obtained.

Due to the fact that only a small temperature rise in the entering air can be expected when the control is in "ICING CONDITIONS", there is no special need for the actual carburetor temperature, since no damage will be caused by accidentally operating with slightly increased air temperatures; thus this indicator is omitted from the instrument panel as a further aid to simplify the airplane.

"17. It is important to have the cowl flaps open during all ground

operation, since many items do not have temperature bulbs attached. This is especially true of spark plug elbows.

"25. The booster pump draws high amperage and should be used only as required; furthermore, the service life of the pump motor has not yet been determined, because the use of the booster pumps is still so recent. Since there is a decided shortage of these pumps on the market, every precaution should be taken to extend their life.

"31. 1600 RPM is chosen, since this is a low cruising RPM and the engine accessories have been designed to operate this slow.

EXPLANATORY NOTE ON BEFORE TAKE-OFF

"16. A 20° flap angle would be used to clear an obstacle; while for minimum ground run, as when operating in mud or sand, a 30° flap angle should be set.

EXPLANATORY NOTE ON CLIMBING

"11. Cowl flaps are necessary in order to provide sufficient enginge cooling over the extreme range of speed at which the airplane must operate. Satisfactory cooling must be provided for ground operation at zero airplane speed, and yet the engine must not operate too cold at 300 MPH. It is, therefore, mandatory that some means be provided to control the cooling air.

In operating the cowl flaps, it will be noticed that those around the top of the engine do not open as wide as those around the bottom. It was necessary to do this in order to prevent an excessive amount of cooling air from striking the tail surfaces and causing a buffeting of the airplane. Fortunately, the aerodynamic conditions at the engine cowling were such that sufficient cooling was achieved even though the upper portion of the cowl flaps opened less than the lower ones.

When operating the cowl flaps, remember that the cylinder temperature will not show an immediate change as the flaps are moved, since a certain amount of time lag is required before the large cylinder actually changes temperature.

EXPLANATORY NOTE ON CRUISING

" 7. Under warm weather conditions, the standard type D-5 thermostatic oil temperature control valve, as installed in Air Corps oil coolers, is sufficient to maintain satisfactory control. With cold air temperatures, when it is necessary to prevent oil congealing or when it is necessary to maintain desirable oil temperature limits, the use of shutters must be employed.

It is generally advisable to maintain sufficiently warm oil so that satisfactory engine lubrication may be obtained, and so that the possibility of congealing will be reduced to a minimum. A special case exists when there is oil congealing. During this condition the oil temperature will become excessive. Under this condition, close the shutters for a short time in order for the congealed cooler to thaw. The shutters may then be opened slightly to allow the temperature to come within the limiting values.

The B-25C incorporates two 10-inch diameter oil coolers per engine. This arrangement was found to be the most suitable for many reasons:

1. At the time of the design studies, 10-inch coolers were the largest which functioned satisfactorily. They were, therefore, chosen in place of one much larger cooler.
2. Two coolers would fit inside the wing, while one large cooler would not.
3. With the cooler hooked up in parallel, the oil pressure drop through them was materially reduced over one cooler. Consequently, more positive scavenging may be achieved.

EXPLANATORY NOTES ON LANDING

" 1. Due to the need for all the effective lifting area possible during landing, the de-icer operation and its accompanying shoe inflation would ruin the proper wing contour; thus a stall or spin might result.

"15. Sufficient loss of lift results when the flaps are raised to cause the airplane to settle. If the airplane is close enough to the ground, a disaster may result.

EXPLANATORY NOTE ON STOPPING ENGINE

" 2. Oil Dilution System T. O. 02-1-29:

An oil dilution system is provided on all B-25 series airplanes. The procedure for oil dilution on Army aircraft is described in T. 0.02-1-29. The procedure directly applicable to the B-25 series is as follows:

The dilution system is used only when a cold weather start is anticipated. The switch that operates the oil dilution solenoid valves is located on the pilot's switch panel with the proper label and a reference to T. O. 02-1-29. This switch operates both solenoid valves simultaneously.

Prior to stopping the engines, idle them at 800 RPM. Hold the oil dilution switch on for approximately four minutes. To

check the operation of the solenoid valves, observe the fuel pressure gauges. The fuel pressure will drop when the valves are operating properly, but not enough to stop the engines. After idling the engines for four minutes with the switch on stop the engines in the normal manner keeping the dilution switch on until the engine stops turning. On the B-25 series airplanes the oil dilution solenoid valves are mounted on the top of the firewall with a flexible conduit running to the power panel on the firewall and copper lines to the carburetor and to the Y oil drain. The fuel is taken from the carburetor through the same Y fitting that connects to the fuel pressure line. The fuel is taken from the carburetor under fuel pressure through the solenoid operated dilution valve and discharges into the Y oil drain fitting located in the oil inlet line at the bottom of the firewall.

According to information received supplementary to T. O. 02-1-29 in a letter from the Army Air Forces Materiel Center, Wright Field, Reference: WM:DM:57, dated December 16, 1940, the following pertinent points should be considered.

The quantity of fuel introduced into the oil system while diluting is not considered critical except that under dilution will result in hard starting and should be avoided at all costs. Tests have been conducted with the dilution valve opened for two to three times the normal four minute period with fuel pressure of 3 to 15 pounds and using both 98 sec. and 120 sec. oil with no adverse effects. There is an actual decrease in the added dilution that occurs in extending the time of dilution because of the increased rate of evaporation that takes place in the crankcase. The required amount of dilution depends primarily upon the air temperature at time of starting, the grade of oil used, and,to some extent, the capacity of the starter.

From past experience of Air Corps operating personnel at Fairbanks, Alaska , for anticipated air temperatures at time of starting down to -18°C (0°F) the normal dilution time of four minutes is sufficient. For anticipated temperatures of -18°C to -31°C it is necessary to dilute once normally for four minutes then shut the engine off and allow it to cool. Then start the engine and dilute again in the normal manner. Diluting a cold engine will substantially increase the amount of the retained dilution. For anticipated temperatures of below -31°C it will be necessary to use engine heaters to pre-heat the engine. In this operation great care should be exercised to prevent accidental ignition of the gas fumes emanating from the engine breathers.

The loss of oil pressure with a particular engine at the same oil temperature and RPM is a reasonable index of the amount of dilution and the drop in fuel pressure when opening the oil dilution valve indicates the approximate pressure drop of the fuel flowing through the dilution line as well as a definite check on the operation of the dilution valve.

It is considered desirable to depend upon the experience of the operating personnel to some extent for obtaining the proper amount of dilution. This is due to the fact that no one factor can be considered critical, but that best results can be obtained by trial with reference to past experience and to the broad limits outlined.

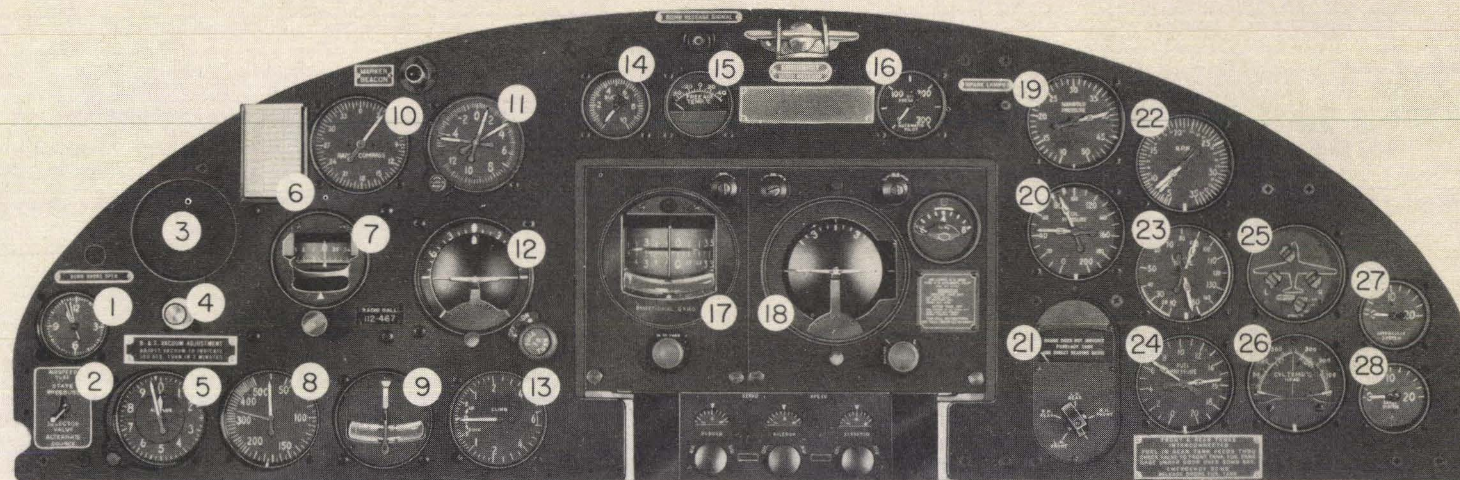
" 4. Not only a better cut-off is obtained at 1500-1600 RPM rather than 600-800, but any accumulation of oil on the plugs should then burn off.

FLYING CHARACTERISTICS, CRUISING CONTROL, ENGINE LIMITATIONS AND FUEL CONSUMPTION.

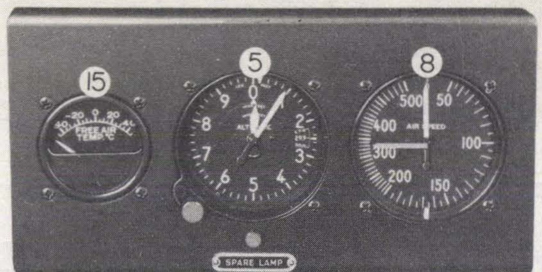
Such items as Flying Characteristics, Cruising Control, Engine Limitations and Fuel Consumption are adequately covered by the Handbook, so the writer has refrained from any elaboration on these subjects. Future Handbooks for the B-25C and B-25D airplanes will incorporate a section on Instructions for Cold Weather Operation.

It should be noted here, however, that future B-25C and B-25D airplanes will be equipped with carburetor air scoops that provide for the installation of carburetor air filters. Engine performance with the air filter installed is effected only in the critical altitude of the engine, this being lowered 1200 feet in high blower from that of the conventional installation. The airplane high speed is reduced approximately 3 MPH. Removing the filter from this scoop does not alter the performance.

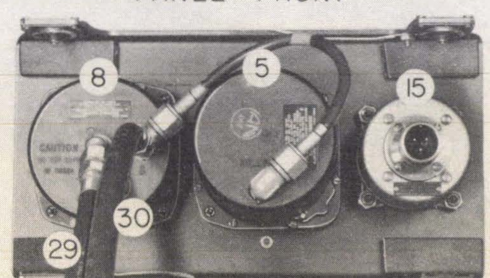
The air filter installation is designed for use during adverse operating conditions where considerable quantities of dust are encountered. For normal operation a baffle has been designed for this scoop to replace the filter. This baffle reduces the expansion space necessary for the filter installation, thus closely approximating a conventional scoop. With this baffle installed, high blower critical altitude is restored to that of the conventional installation. Although the baffle enriches the mixture approximately 2% at high powers in high blower only,this is not detrimental and has no appreciable effect on performance.



1. PILOT'S CLOCK
2. STATIC PRESSURE SELECTOR VALVE
3. (PROVISION FOR) PILOT DIRECTOR INDICATOR
4. BANK & TURN NEEDLE VALVE
5. ALTIMETER
6. ALTIMETER CORRECTION CARD
7. TURN INDICATOR
8. AIRSPEED INDICATOR
9. BANK & TURN INDICATOR
10. RADIO COMPASS
11. ACCELEROMETER
12. FLIGHT INDICATOR
13. RATE OF CLIMB INDICATOR
14. SUCTION (VACUUM) GAUGE
15. FREE AIR TEMPERATURE INDICATOR
16. AUTO PILOT OIL PRESSURE GAUGE



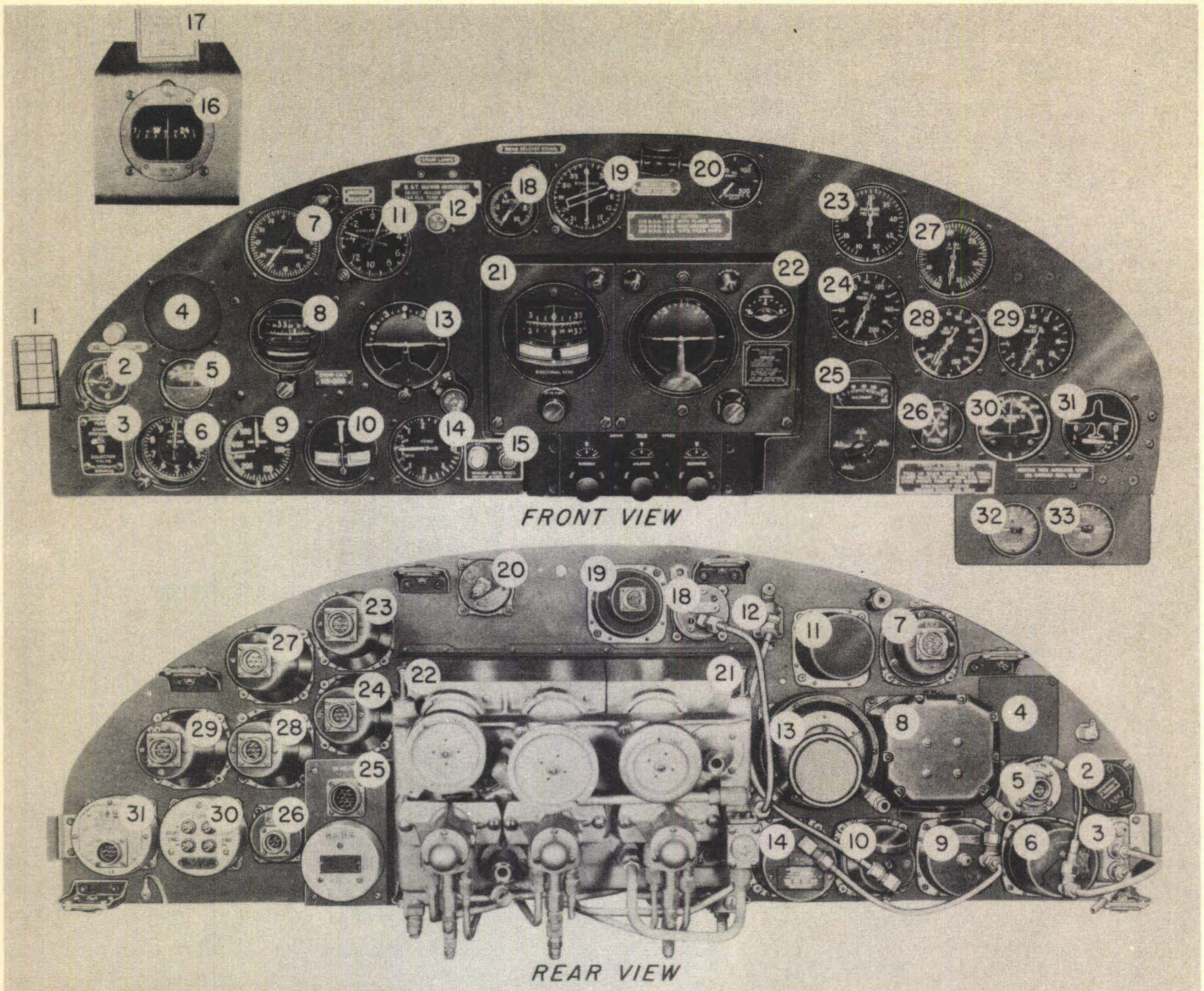
BOMBARDIER'S INSTRUMENT PANEL - FRONT



BOMBARDIER'S INSTRUMENT PANEL - REAR

17. AUTO PILOT DIRECTIONAL GYRO UNIT
18. AUTO PILOT BANK & CLIMB GYRO UNIT
19. MANIFOLD PRESSURE INDICATOR
20. OIL PRESSURE INDICATOR
21. FUEL LEVEL INDICATOR
22. TACHOMETER INDICATOR
23. OIL TEMPERATURE INDICATOR
24. FUEL PRESSURE INDICATOR
25. LANDING GEAR & FLAP POSITION INDICATOR
26. CYLINDER-HEAD TEMPERATURE INDICATOR
27. HYDRAULIC PRESSURE GAUGE
28. BRAKE PRESSURE GAUGE
29. AIRSPEED PRESSURE LINE
30. STATIC PRESSURE LINE

FIG. 1 PILOT'S & BOMBARDIER'S INSTRUMENT PANELS (EARLY B-25C & B-25D AIRPLANES)



1. ALTIMETER CORRECTION CARD
2. PILOT'S CLOCK
3. STATIC PRESSURE SELECTOR VALVE
4. (PROVISION FOR) PILOT DIRECTOR INDICATOR
5. FREE AIR TEMPERATURE INDICATOR
6. ALTIMETER
7. RADIO COMPASS
8. TURN INDICATOR
9. AIRSPEED INDICATOR
10. BANK & TURN INDICATOR
11. ACCELEROMETER
12. BANK & TURN NEEDLE VALVE
13. FLIGHT INDICATOR
14. RATE OF CLIMB INDICATOR
15. NOSE WHEEL TURN INDICATOR
16. MAGNETIC COMPASS
17. COMPASS CORRECTION CARD
18. SUCTION (VACUUM) GAUGE
19. REMOTE READING COMPASS
20. AUTO PILOT OIL PRESSURE GAUGE
21. AUTO PILOT DIRECTIONAL GYRO UNIT
22. AUTO PILOT BANK & CLIMB GYRO UNIT
23. MANIFOLD PRESSURE GAUGE
24. OIL PRESSURE GAUGE
25. MAIN TANKS FUEL LEVEL INDICATOR
26. AUXILIARY TANKS FUEL LEVEL INDICATOR
27. TACHOMETER INDICATOR
28. OIL TEMPERATURE INDICATOR
29. FUEL PRESSURE INDICATOR
30. CYLINDER HEAD TEMPERATURE INDICATOR
31. LANDING GEAR & FLAP POSITION INDICATOR
32. HYDRAULIC PRESSURE GAUGE
33. BRAKE PRESSURE GAUGE

FIG. 2 PILOT'S INSTRUMENT PANEL (RECENT B-25C AND B-25D AIRPLANES)

INTRODUCTION

Instruments and their related systems are the nerve center of the modern bomber. They must be functioning at top efficiency if the airplane is to be an effective fighting machine. Keeping them in top order is the important job of the maintenance crew.

Of all parts of the airplane, the instruments are the most fragile. They are the products of skilled precision work, and their maintenance and repair require equally careful workmanship. Any instrument suspected or found to be defective should be replaced, and the defective instrument sent to the base repair station. Nevertheless, much instrument inspection and maintenance work remains for the Field Service man. A complete knowledge of the function and care of instruments and their related equipment will enable him to keep the instrument systems in perfect working order.

This lecture should be supplemented by study of the proper Technical Orders and the Handbook of the B-25 Bomber.

TYPES OF INSTRUMENT EQUIPMENT

Instruments may be divided into four general groups:*

1. Vacuum Instruments
2. Airspeed and Pitot-Static Instruments
3. Engine Instruments
4. Miscellaneous Instruments

VACUUM INSTRUMENTS AND EQUIPMENT

We shall first consider the vacuum instruments and their associated pieces of equipment. These consist of Vacuum Pumps, Oil Separators, Check Valves, Relief Valves, Suction Gauge, Sperry A-3 Auto Pilot, Bank and Turn Indicator, Bank and Turn Needle Valve, Flight Indicator, Turn Indicator, and Camera Vacuum Shut-off Valve.

Vacuum Systems

Airplanes With A.F.C. Equipment

On airplanes with A.F.C. Equipment, a single vacuum system is operated by two vacuum pumps, one at each engine. Each pump has sufficient capacity to operate the entire system throughout the range of engine speeds between 1000 and 2600 RPM.

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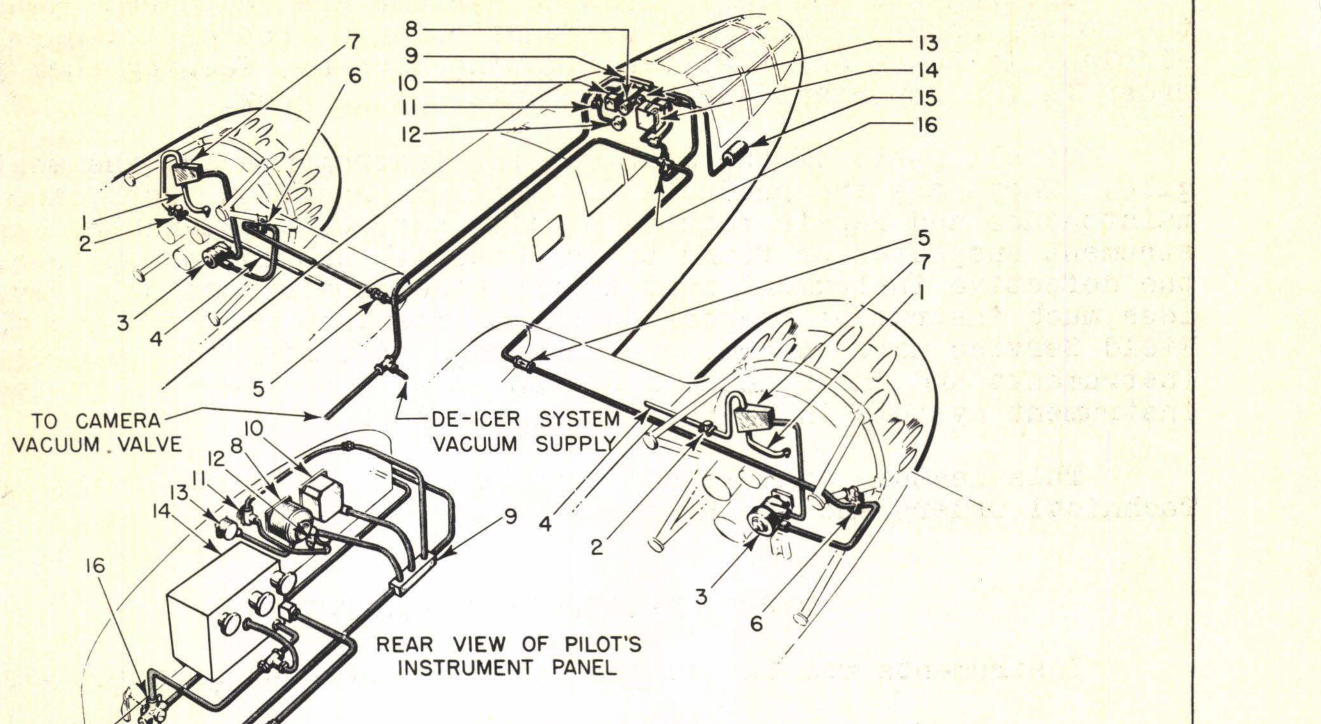
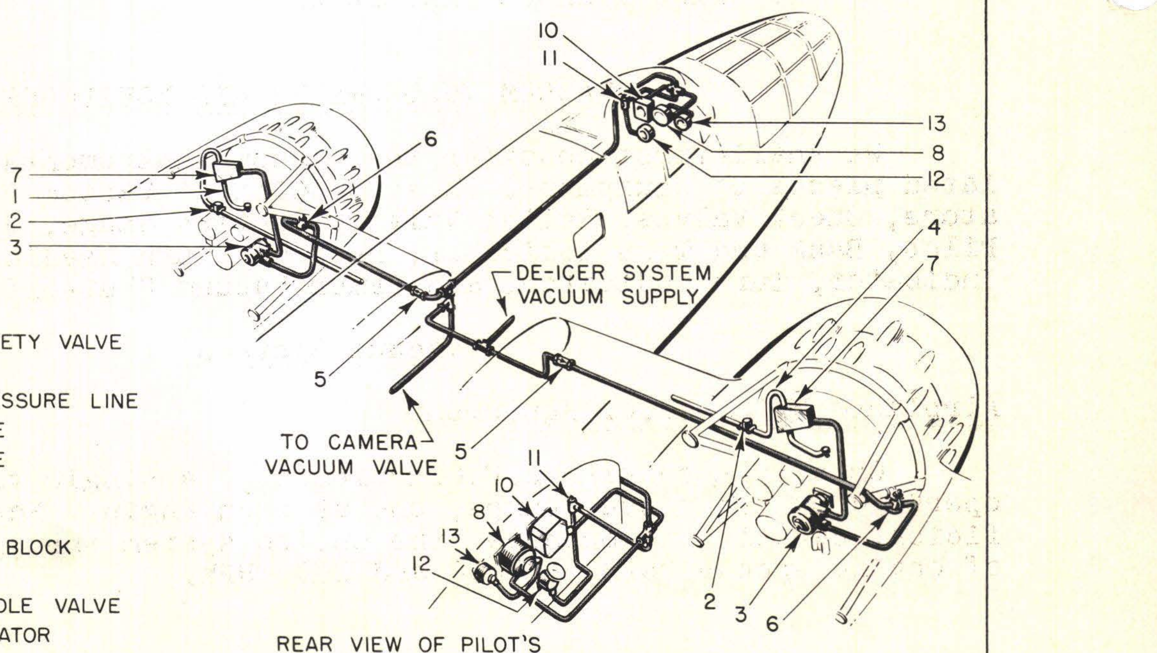
*Note: For convenience in reference, a full list of instrument equipment, divided according to station, and including specification numbers, is given on pages 30 - 32.



AIRPLANES WITH A-3 AUTO PILOT



AIRPLANES WITH A.F.C.E.

LEGEND

1. OIL RETURN LINE
2. DE-ICER SYSTEM SAFETY VALVE
3. VACUUM PUMP
4. DE-ICER SYSTEM PRESSURE LINE
5. VACUUM CHECK VALVE
6. VACUUM RELIEF VALVE
7. OIL SEPARATOR
8. FLIGHT INDICATOR
9. VACUUM DISTRIBUTOR BLOCK
10. TURN INDICATOR
11. BANK AND TURN NEEDLE VALVE
12. BANK AND TURN INDICATOR
13. SUCTION GAGE
14. AUTOMATIC PILOT GYRO UNITS
15. AUTOMATIC PILOT AIR FILTER
16. VACUUM SELECTOR VALVE

FIG. 3 VACUUM SYSTEM INSTALLATIONS

Sperry A-3 Auto Pilot Vacuum System

Airplanes equipped with the Sperry A-3 Automatic Pilot differ in that there are two vacuum systems, one for the Flight Instruments and one for the Automatic pilot. Because one pump does not have sufficient capacity to operate both systems, each system is operated by only one pump. However, a selector valve does make it possible to operate either system from either one of the two pumps. The valve, located on the pilot's right auxiliary instrument panel (below the main panel), may be set to either of two positions, as follows:

1. Left vacuum pump on Automatic Pilot; right vacuum pump on Flight Instruments. 2. Right vacuum pump on Automatic Pilot; left vacuum pump on Flight Instruments. Vacuum lines have been so arranged and installed as to make this possible.

Camera Vacuum

Camera vacuum is obtained from the Flight Instrument vacuum line. A shut-off valve is located on the left wall of the camera compartment.

Vacuum Pumps

With both A.F.C. Equipment and Sperry Automatic Pilot equipment, two vacuum pumps, type B-12, are used, one at each engine. This type pump is designed to provide a flow of not less than 7-1/2 cubic feet of free air per minute when operating at 1500 RPM, 4 inches of mercury inlet suction, and 1 inch of mercury outlet pressure. Each pump also provides a flow of not less than 8 cubic feet of free air per minute when operating at 2250 RPM, 4 inches of mercury inlet suction, and 16 inches of mercury outlet pressure. The ratio of pump RPM to engine RPM is 1-1/2 to 1.

Sealed Ball-Bearing

The engine drive-seal connection of this pump has been improved over previous models, making the use of a pressure by-pass line and pressure or suction vent plugs unnecessary. A sealed ball-bearing replaces the old standard ball-bearing at the drive end of the rotor shaft. The seal of this new bearing eliminates any suction around the coupling which might draw oil or oil vapor from the engine drive shaft in the event the accessory case seal at the spline drive bearing in the vacuum mounting pad is faulty.

The vacuum pump is lubricated through an oil duct in the engine mounting pad, connecting with another oil duct in the pump mounting pad. When installing the pump, make certain that the gasket holes, the engine pad oil duct, and the vacuum pump oil duct are all in ALIGNMENT. The high speed (4000 RPM) of the pump rotor makes necessary good lubrication at all times to prevent seizure.

Oil Separators

A B-12 primary oil separator is installed in each vacuum pump

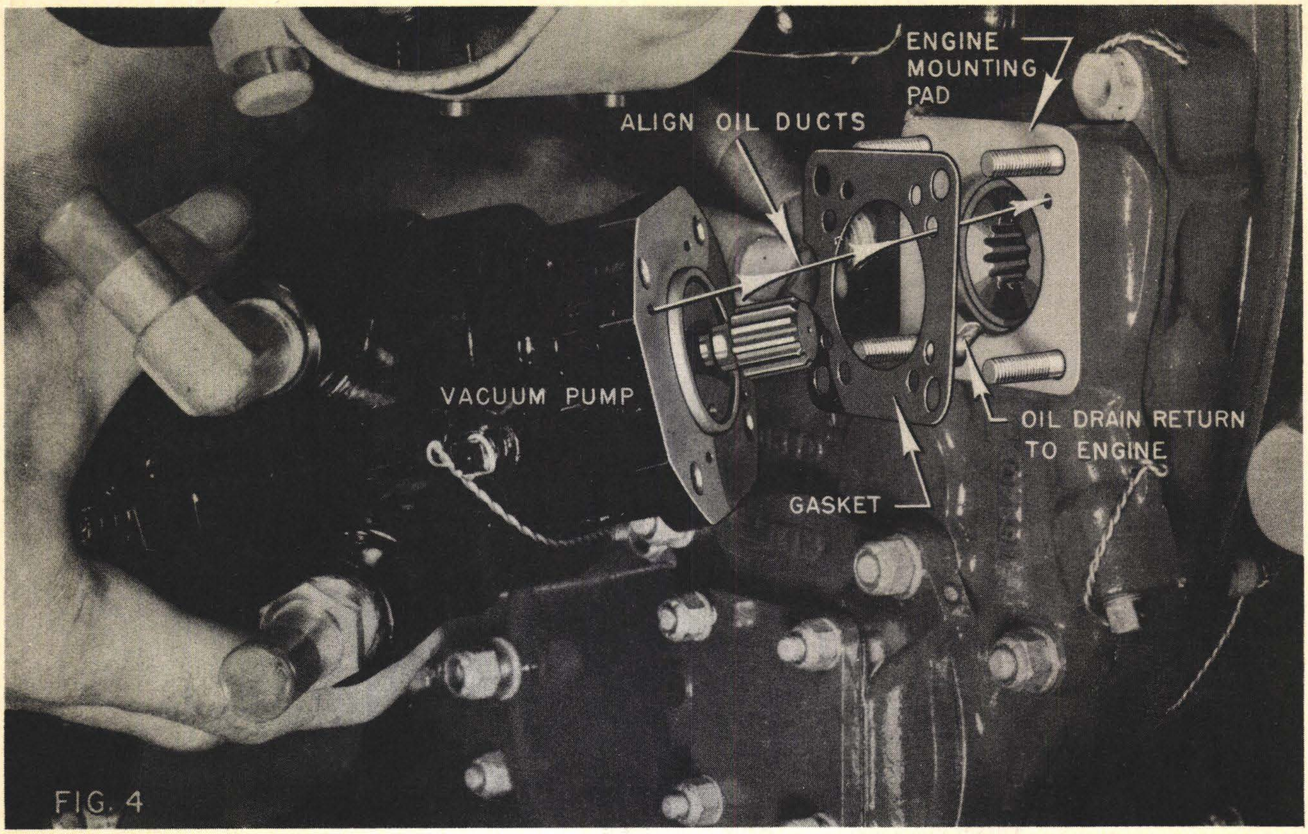
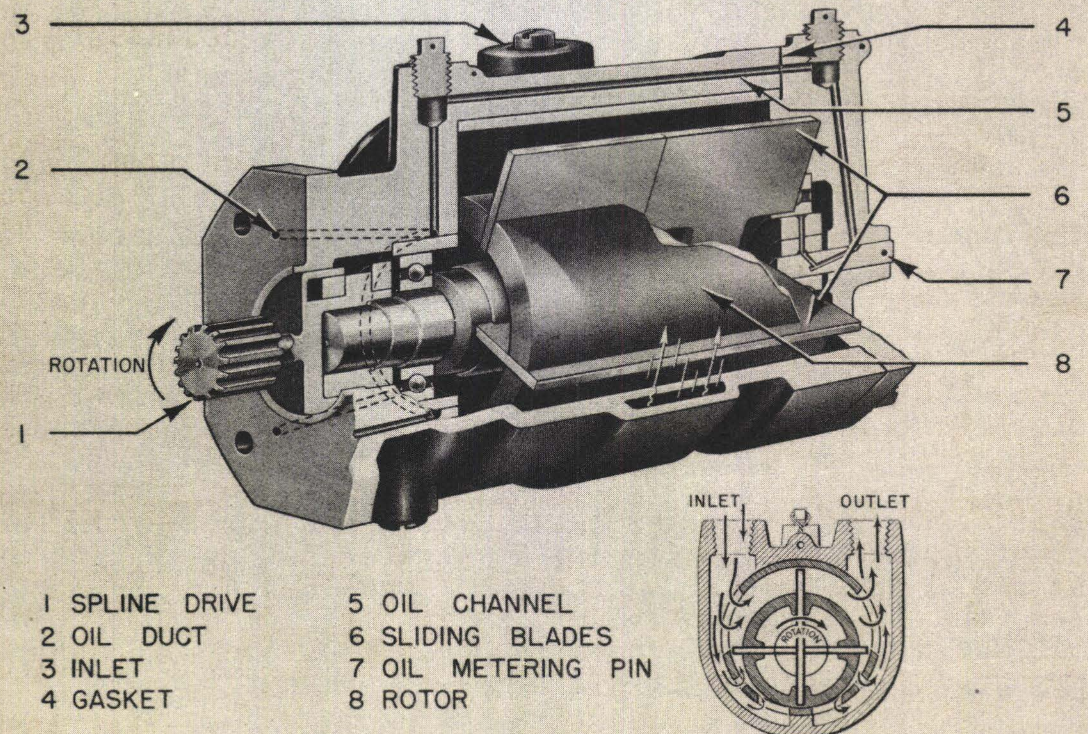


FIG. 4



1 SPLINE DRIVE
2 OIL DUCT
3 INLET
4 GASKET
5 OIL CHANNEL
6 SLIDING BLADES
7 OIL METERING PIN
8 ROTOR

FIG. 5 B-12 VACUUM PUMP

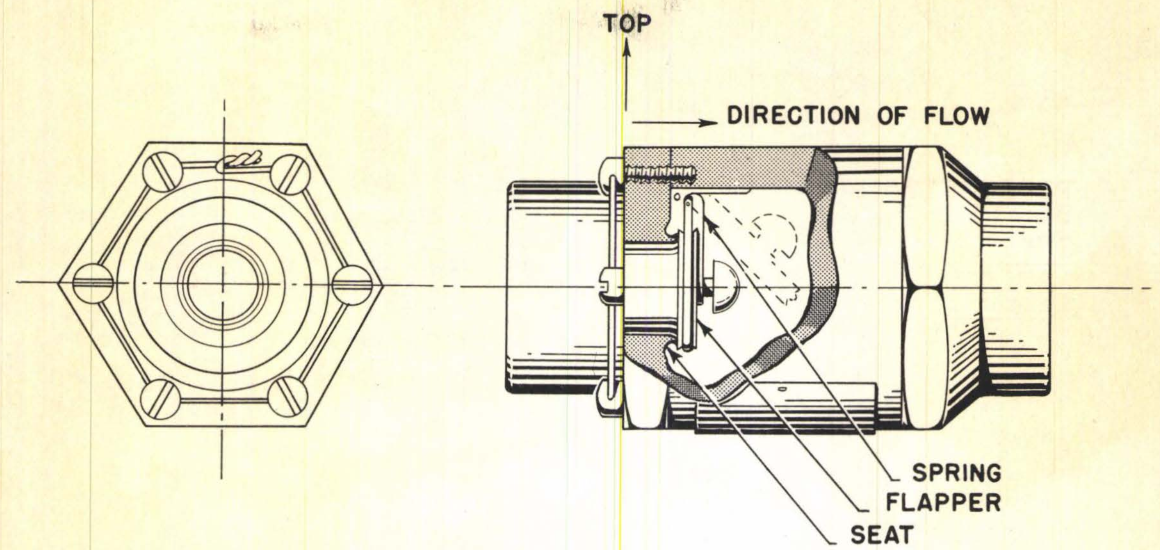


FIG. 6 CHECK VALVE

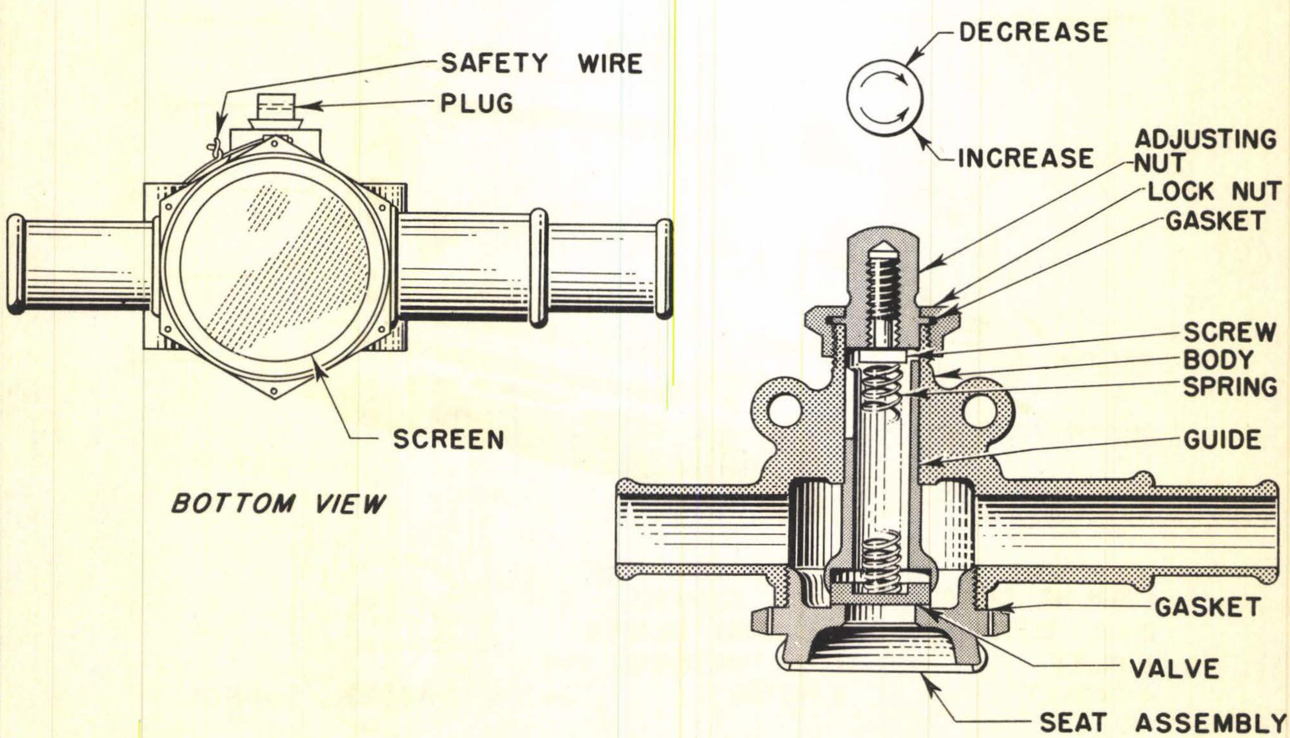


FIG. 7 RELIEF VALVE

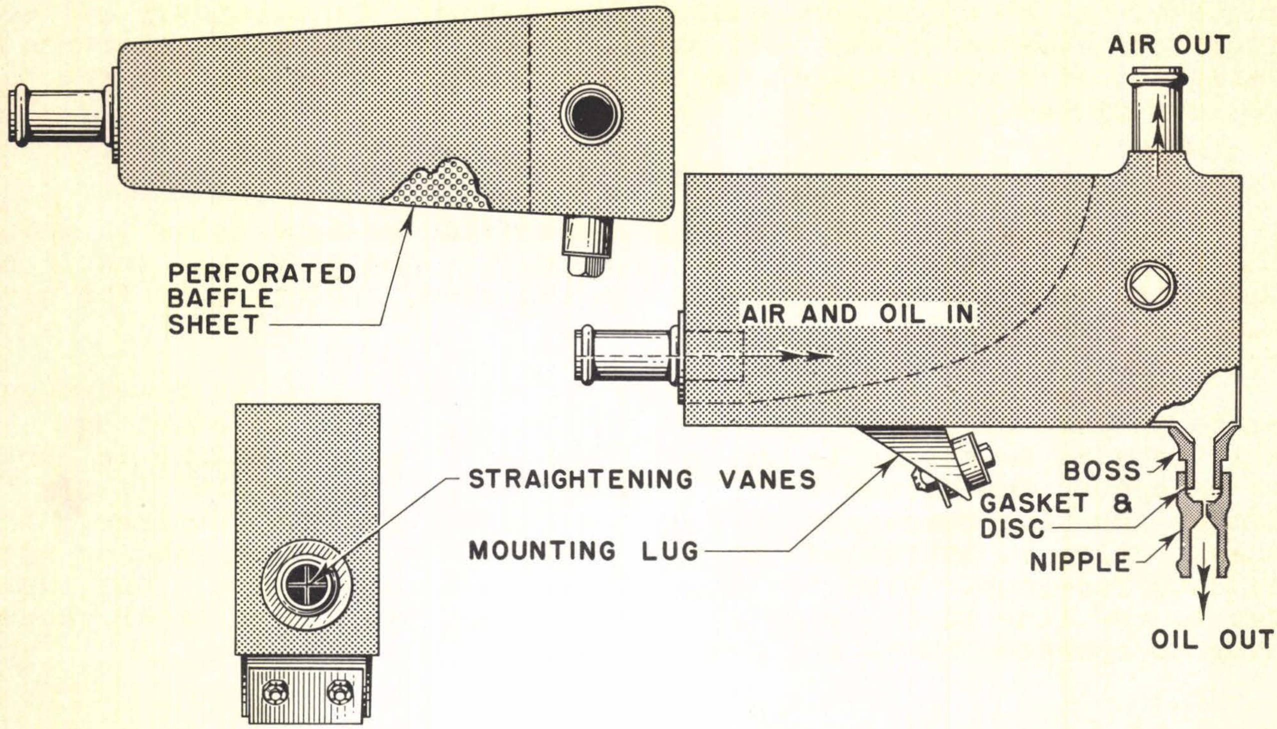


FIG. 8 OIL SEPARATOR

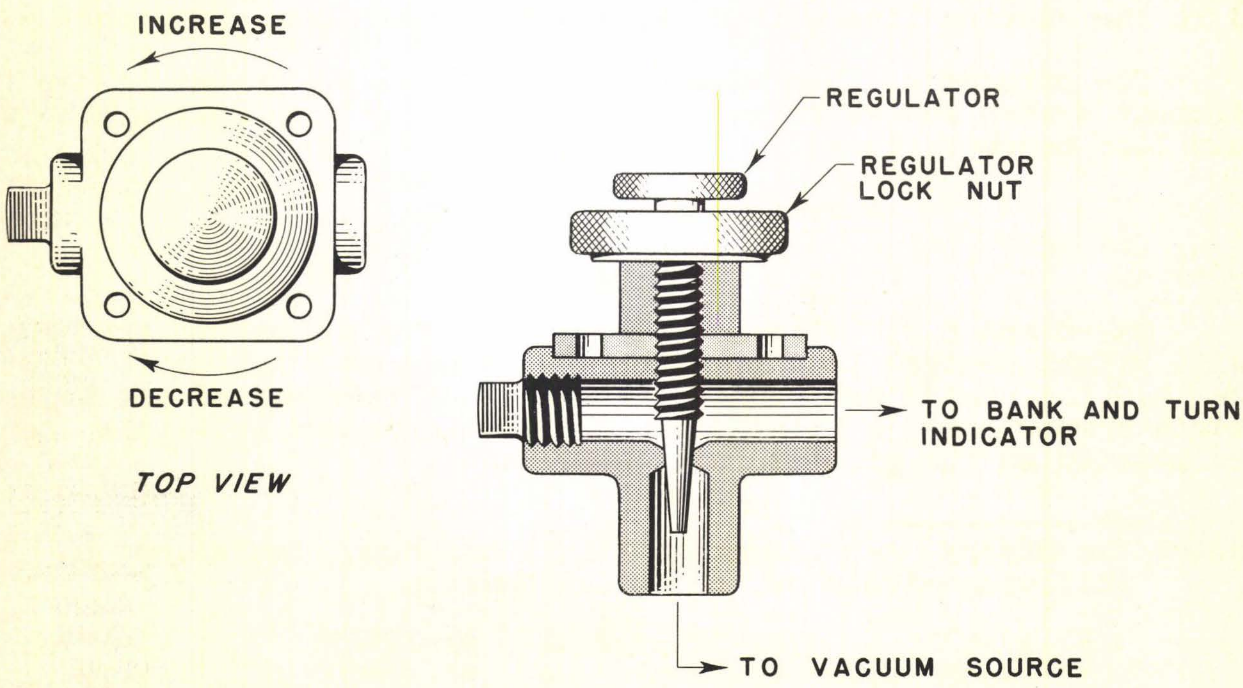


FIG. 9 BANK AND TURN NEEDLE VALVE

discharge line for the purpose of removing any oil from the pump discharge air used to operate the de-icer system. The oil removed is returned to the engine crankcase. In addition, one secondary oil separator, located in the aft part of the navigator's compartment, serves to eliminate any oil vapor which might be passed on to the de-icer system.

Check Valve

The check valve is a spring-loaded flapper-type valve in which the flapper is held open by the suction of the pump. It should be installed with the arrow mark on the top side, pointing in the direction of the airflow.

Purpose of the check valve is to prevent damage to the instruments in case of engine reversals, which may occur in starting. It also acts as an automatic cut-off in case of pump or engine failure, or damage to the vacuum line. Because enemy fire is most likely to damage the line somewhere between the nacelle and the fuselage, the check valve is installed at the junction of the wing leading edge and the fuselage. With the check valve in this position, any damage to the line in the wing will not prevent use of the other vacuum pump to operate the Flight Instruments.

Relief Valve

The type B-12 relief valve is a spring-loaded disc-type valve, in which the disc is held against a screened valve-seat by a spring. The tension of this spring may be altered by an adjustment nut on the outside of the housing. The valve is mounted with the screened opening facing downward, NEVER facing upward. The valve is installed in the suction line within 24 inches of the vacuum pump port.

The purpose of this valve is to regulate the vacuum in the instrument system and to relieve the pump if, for some reason, the vacuum line becomes closed.

Automatic Pilot Operation

B-25C and B-25D airplanes are equipped with either the Automatic Flight Control Equipment or the Sperry A-3 Automatic Pilot.* The A.F.C.E. units are located in the upper rear end of the bombardier's compartment. A pilot direction indicator and tell-tale lights are mounted on the pilot's instrument panel.

---

*Note: The Sperry A-3 Automatic Pilot has been installed on the following airplanes, AC Serial Numbers:

41-12457	41-12459	41-12461	41-12463
41-12465	41-12467	41-12469	41-12471
41-12473	41-12475	41-12477	41-12479

41-12517 and subsequent B-25C
41-29848 and subsequent B-25D

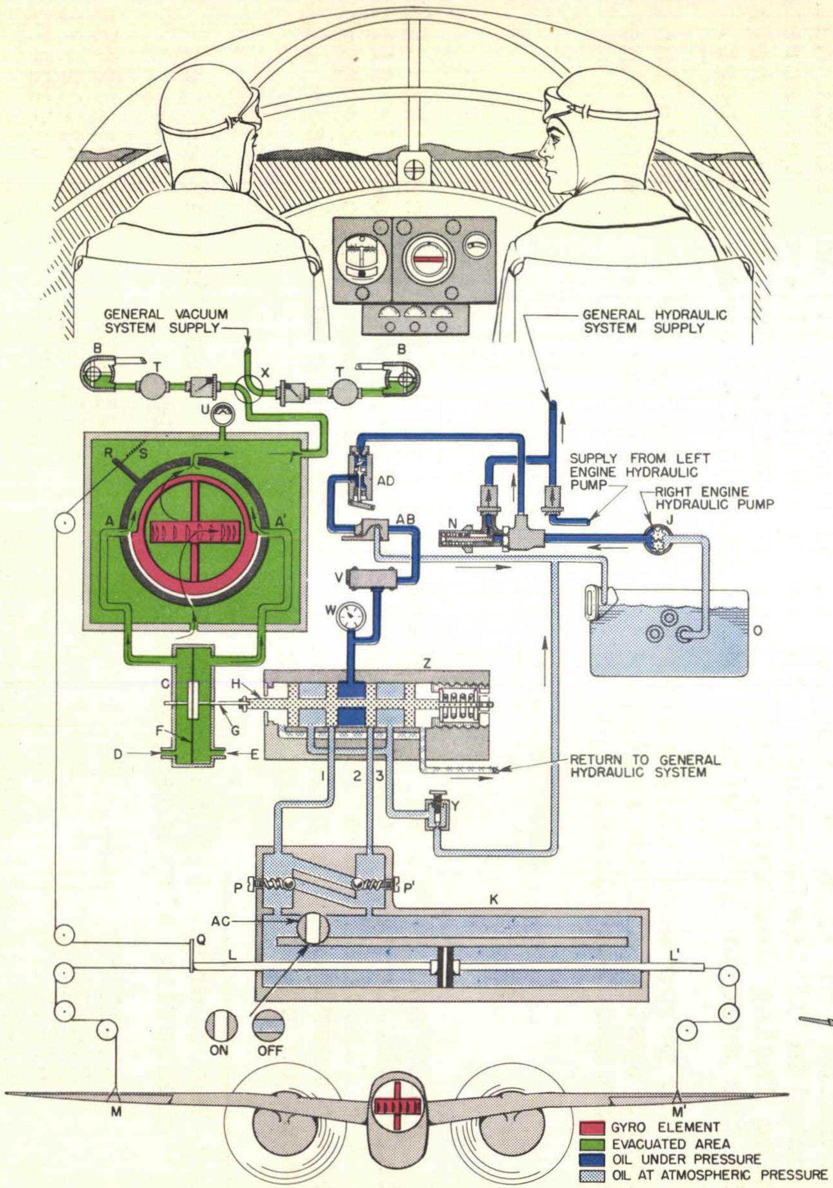


FIG. 10 AUTOMATIC PILOT SYSTEM LINES DIAGRAM (AIRPLANE LEVEL)

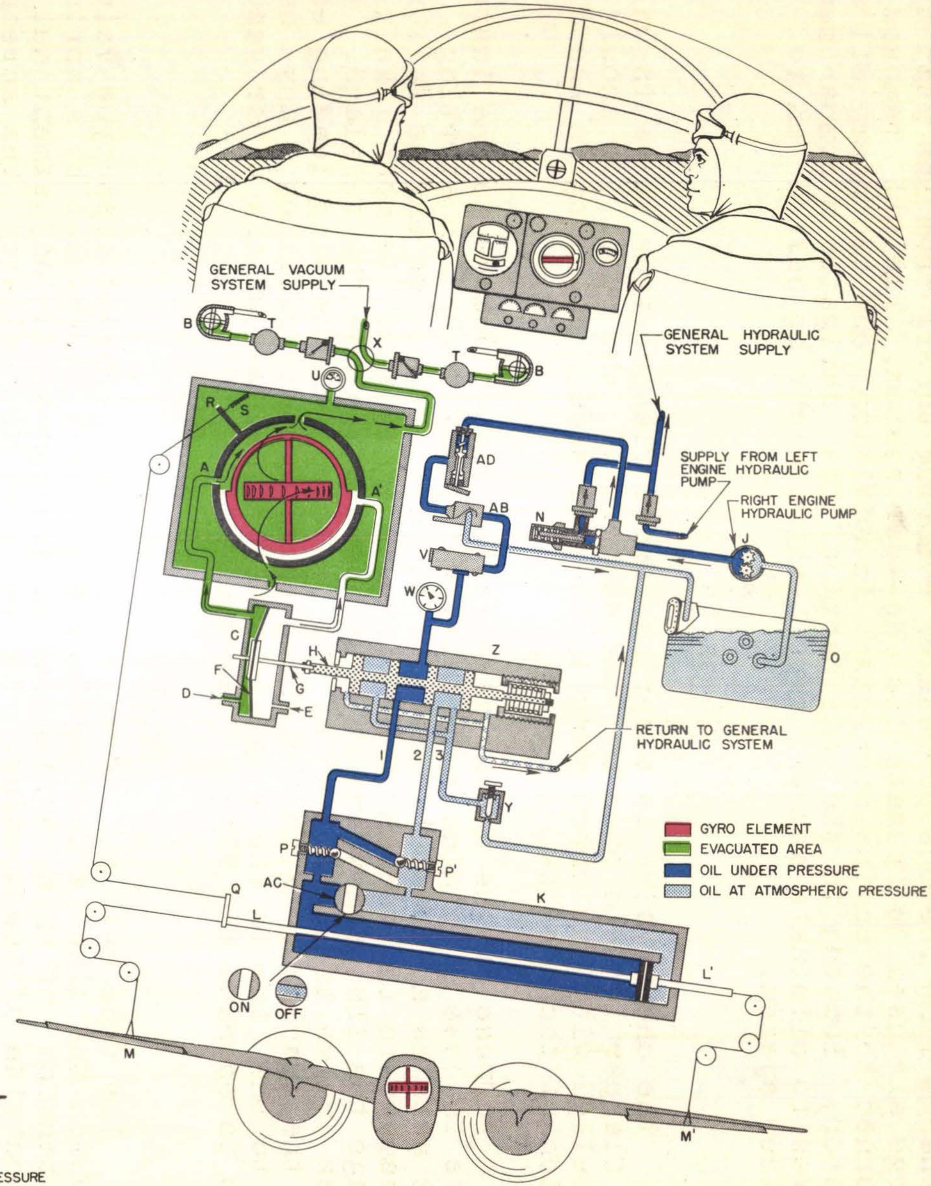


FIG. 11 AUTOMATIC PILOT SYSTEM LINES DIAGRAM (RIGHT WING DOWN)

discharge line for the purpose of removing any oil from the pump discharge air used to operate the de-icer system. The oil removed is returned to the engine crankcase. In addition, one secondary oil separator, located in the aft part of the navigator's compartment, serves to eliminate any oil vapor which might be passed on to the de-icer system.

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41-12517 and subsequent B-25C
41-29848 and subsequent B-25D

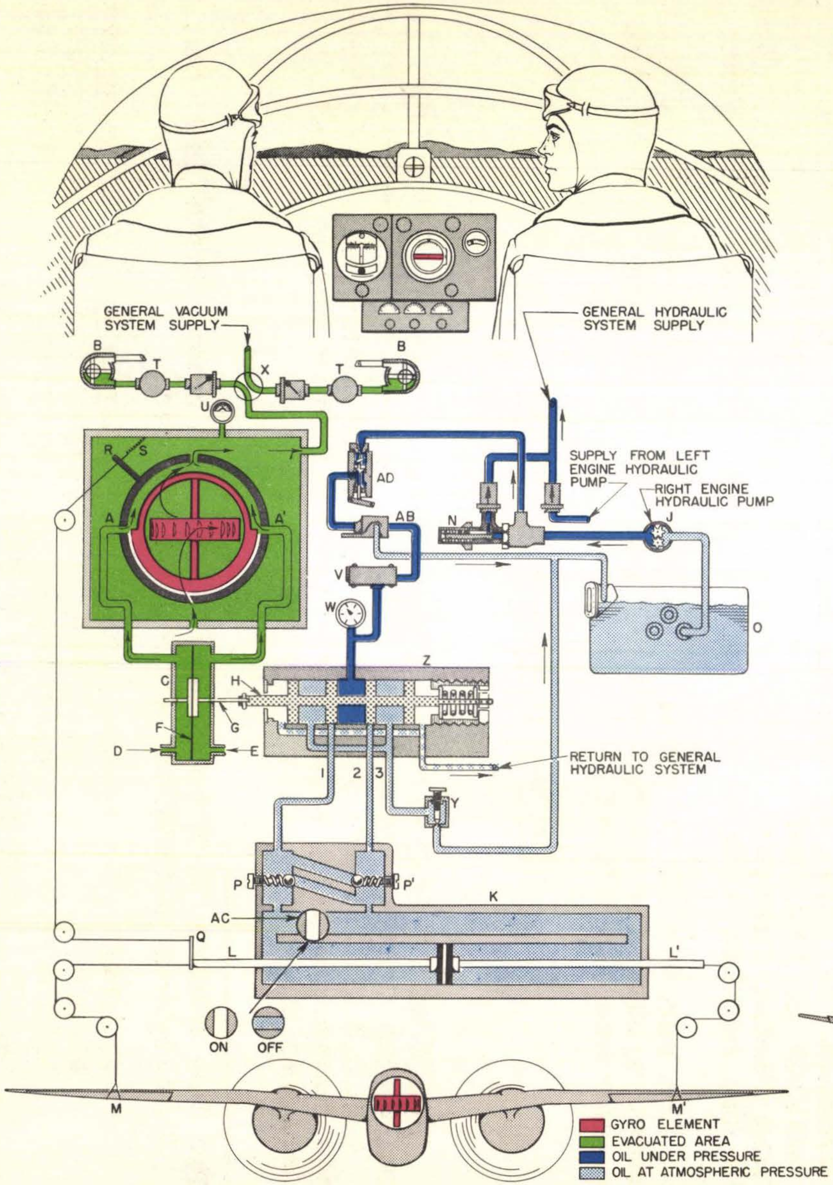


FIG. 10 AUTOMATIC PILOT SYSTEM LINES DIAGRAM (AIRPLANE LEVEL)

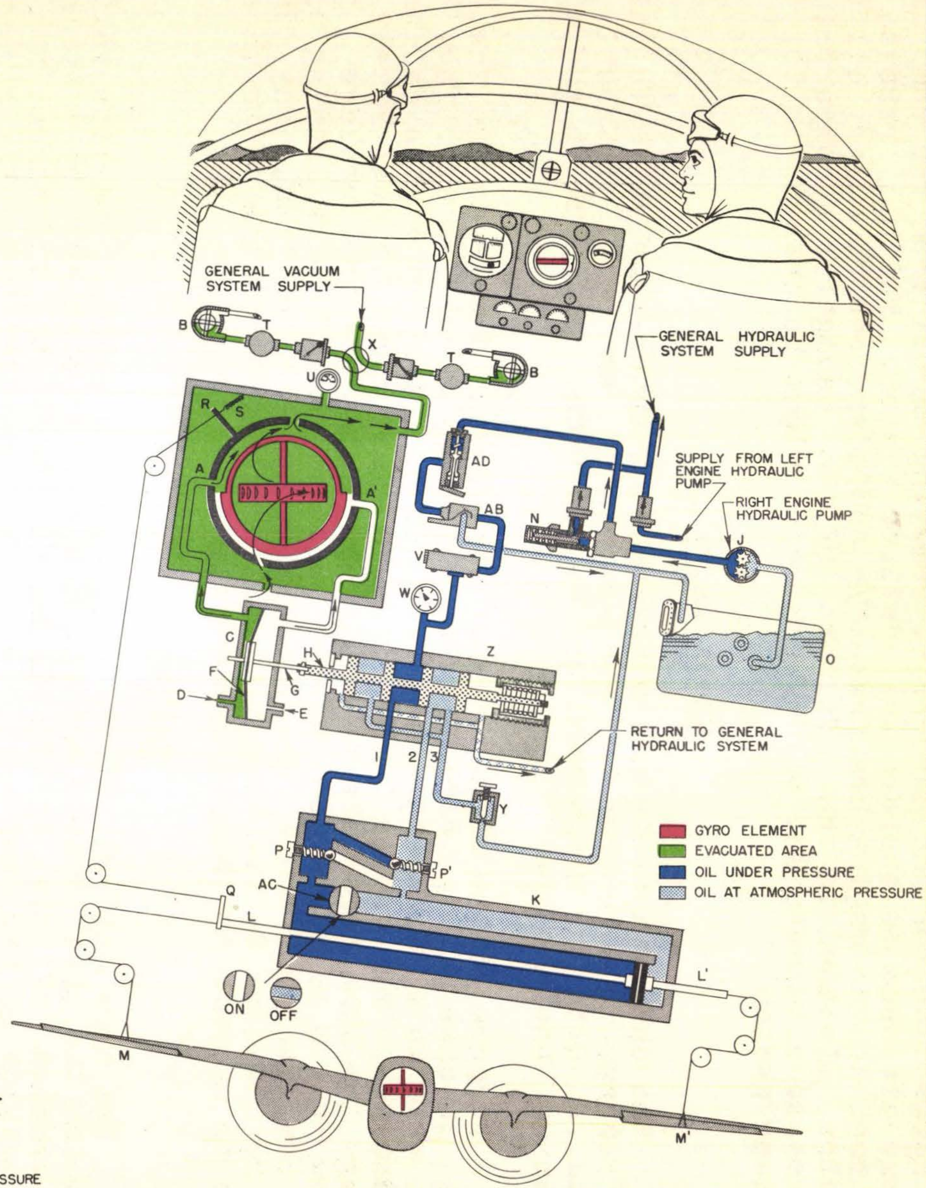


FIG. 11 AUTOMATIC PILOT SYSTEM LINES DIAGRAM (RIGHT WING DOWN)

discharge line for the purpose of removing any oil from the pump discharge air used to operate the de-icer system. The oil removed is returned to the engine crankcase. In addition, one secondary oil separator, located in the aft part of the navigator's compartment, serves to eliminate any oil vapor which might be passed on to the de-icer system.

Check Valve

The check valve is a spring-loaded flapper-type valve in which the flapper is held open by the suction of the pump. It should be installed with the arrow mark on the top side, pointing in the direction of the airflow.

Purpose of the check valve is to prevent damage to the instruments in case of engine reversals, which may occur in starting. It also acts as an automatic cut-off in case of pump or engine failure, or damage to the vacuum line. Because enemy fire is most likely to damage the line somewhere between the nacelle and the fuselage, the check valve is installed at the junction of the wing leading edge and the fuselage. With the check valve in this position, any damage to the line in the wing will not prevent use of the other vacuum pump to operate the Flight Instruments.

Relief Valve

The type B-12 relief valve is a spring-loaded disc-type valve, in which the disc is held against a screened valve-seat by a spring. The tension of this spring may be altered by an adjustment nut on the outside of the housing. The valve is mounted with the screened opening facing downward, NEVER facing upward. The valve is installed in the suction line within 24 inches of the vacuum pump port.

The purpose of this valve is to regulate the vacuum in the instrument system and to relieve the pump if, for some reason, the vacuum line becomes closed.

Automatic Pilot Operation

B-25C and B-25D airplanes are equipped with either the Automatic Flight Control Equipment or the Sperry A-3 Automatic Pilot.* The A.F.C.E. units are located in the upper rear end of the bombardier's compartment. A pilot direction indicator and tell-tale lights are mounted on the pilot's instrument panel.

*Note: The Sperry A-3 Automatic Pilot has been installed on the following airplanes, AC Serial Numbers:

41-12457	41-12459	41-12461	41-12463
41-12465	41-12467	41-12469	41-12471
41-12473	41-12475	41-12477	41-12479

41-12517 and subsequent B-25C
41-29848 and subsequent B-25D

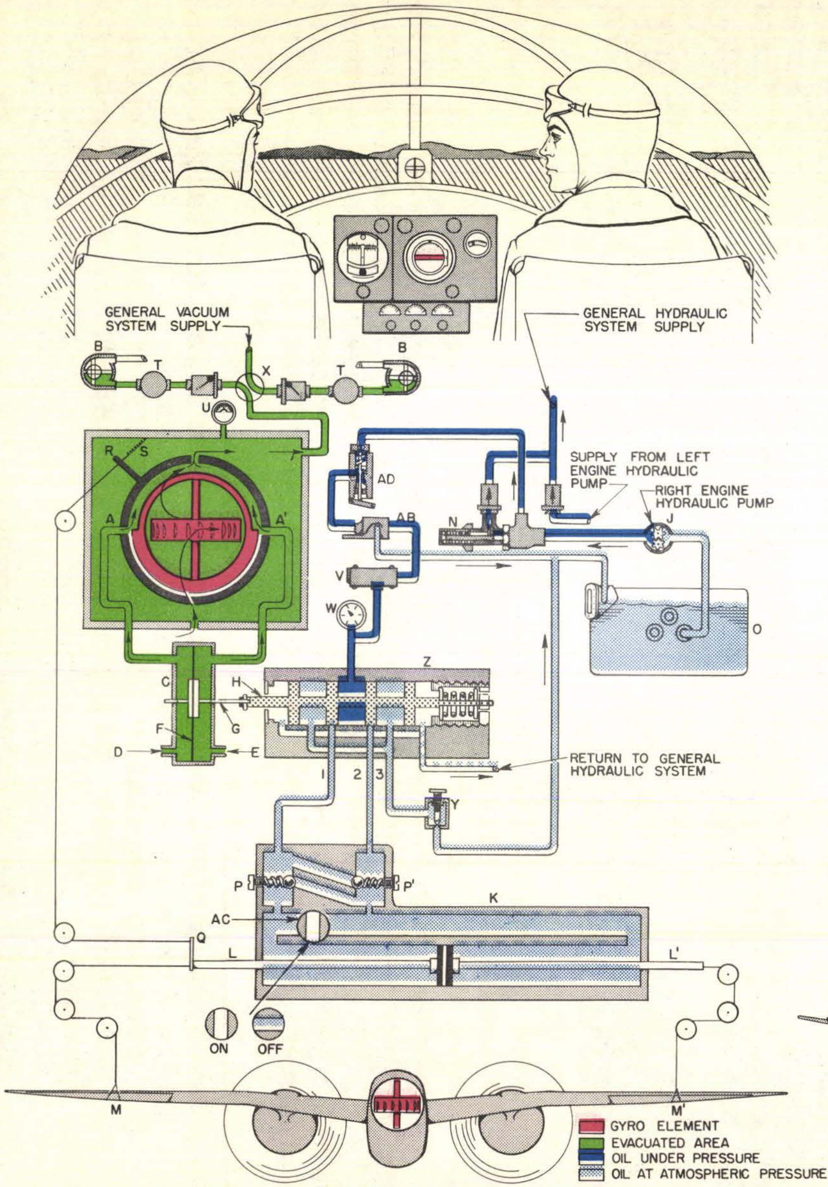


FIG. 10 AUTOMATIC PILOT SYSTEM LINES DIAGRAM (AIRPLANE LEVEL)

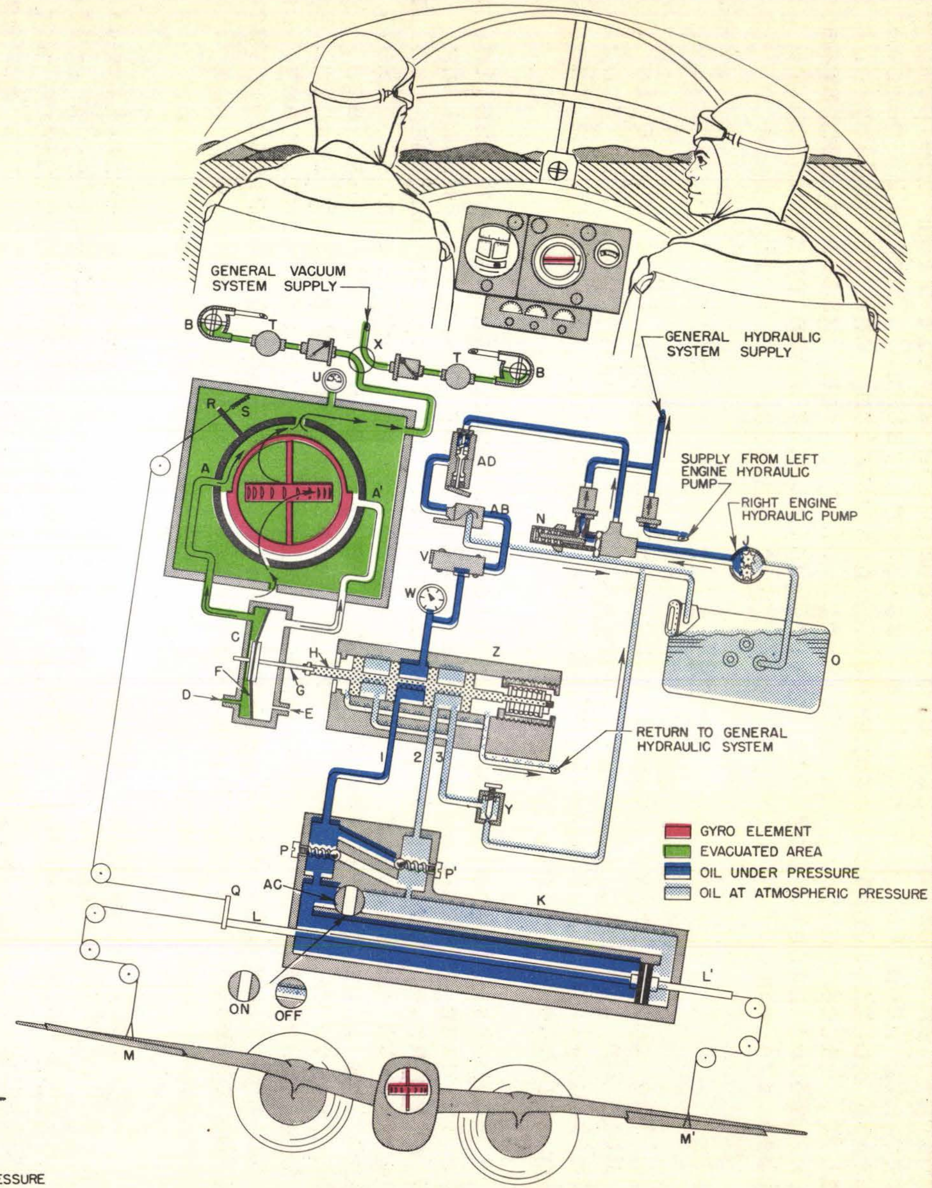


FIG. 11 AUTOMATIC PILOT SYSTEM LINES DIAGRAM (RIGHT WING DOWN)

Sperry A-3 Automatic Pilot

Function of the Sperry Pilot is based on the principle of action of the gyroscope, a spinning wheel which exhibits a characteristic called "rigidity", that is it tends to remain in whatever position it is set. The directional gyro rotates with its axle horizontal, but it is able to move freely in any direction. Once the gyro is set for a particular course a change to right or left in the course of the airplane will be shown on the compass card, and the Automatic Pilot will operate the controls to return the plane to its proper course. The bank and climb gyro, mounted with its axle vertical, works in the same way to show and control changes in bank and climb movements of the airplane.

Both gyro wheels, operating as turbines, are rotated by vacuum at 12,000 RPM. Through a single pneumatic-hydraulic system the air "pick-offs" cause movement of the surface controls to keep the airplane on its course.

Operation

To illustrate the operation of the Automatic Pilot, only the aileron control of the Bank and Climb gyro will be described. The rudder and elevator controls are operated in a similar manner.

The gyro is supported in a gimbal ring which has a disc with knife edges attached to it. These parts, which comprise the sensitive element, are shown in red in the box on Figs. 10 and 11.

The air pick-offs (A-A') surrounding the sensitive element are also enclosed within the box. Air is drawn into the bottom of the box by the suction pump (B) which is selected by the selector valve (X), and directed to the gyro to spin it. Air is also drawn in from the air relay (C) through ports (A-A') and exhausted at the top of the box. The air relay (C) has two inlet ports (D) and (E), one on either side of the diaphragm (F). The diaphragm is connected by the rod (G) to the core of the balanced oil valve (H)in which a constant oil pressure is maintained by the oil pump (J). Movement of the core of the balanced oil valve to the left or right permits oil to flow to the servo unit (K) where it moves the piston rod (L-L') one way or the other. The piston rod is connected to the control cables which operate the ailerons (M-M'). In Fig. 10, the airplane is assumed to be level laterally and the automatic pilot is therefore neutral. The gyro is upright and the knife edges of the disc intercept an equal amount of air which is being drawn in from the air relay (C) through ports (D) and (E); therefore, an equal suction is maintained at both sides of the diaphragm (F), the balanced oil valve piston is centralized, and no oil can flow to the servo unit.

The pressure regulator (N) relieves all oil pressure above 125 lbs./sq. in. All excess oil pressure is routed to the general hydraulic system.

In Fig. 11, the airplane is assumed to be displaced laterally

(to an exaggerated degree) so that the right wing is lower than the left. Because of its characteristic of "rigidity" the gyro maintains its vertical axis, and port (A') of the air pick-off system is closed. Since port (A) is open, the suction on the left-hand side of the diaphragm (F) is increased and the diaphragm moves to the left. The corresponding movement of the balanced oil valve core permits oil to flow through line No. 1 to the servo unit where it passes around the over-power valve (P) and enters the servo unit moving the piston to the right and applying the necessary aileron control to restore the airplane laterally to level flight.

The oil from the other side of the piston returns to the balanced oil valve through line No. 2 and flows back to the hydraulic system oil sump through line No. 3. The important part of the system, the follow-up,is also shown diagramatically in Figs. 10 and 11. The follow-up provides a means whereby the applied control is removed as the airplane is returning to its normal attitude so that the control surface will be back in its neutral or centered position when the disturbance has been fully corrected.

The air pick-offs (A-A') are not fixed rigidly to the gyro box but can be moved in relation to the gyro element by means of the follow-up mechanism. A cable is connected to the servo piston rod at (Q) and attached to the lever (R) on the follow-up assembly.

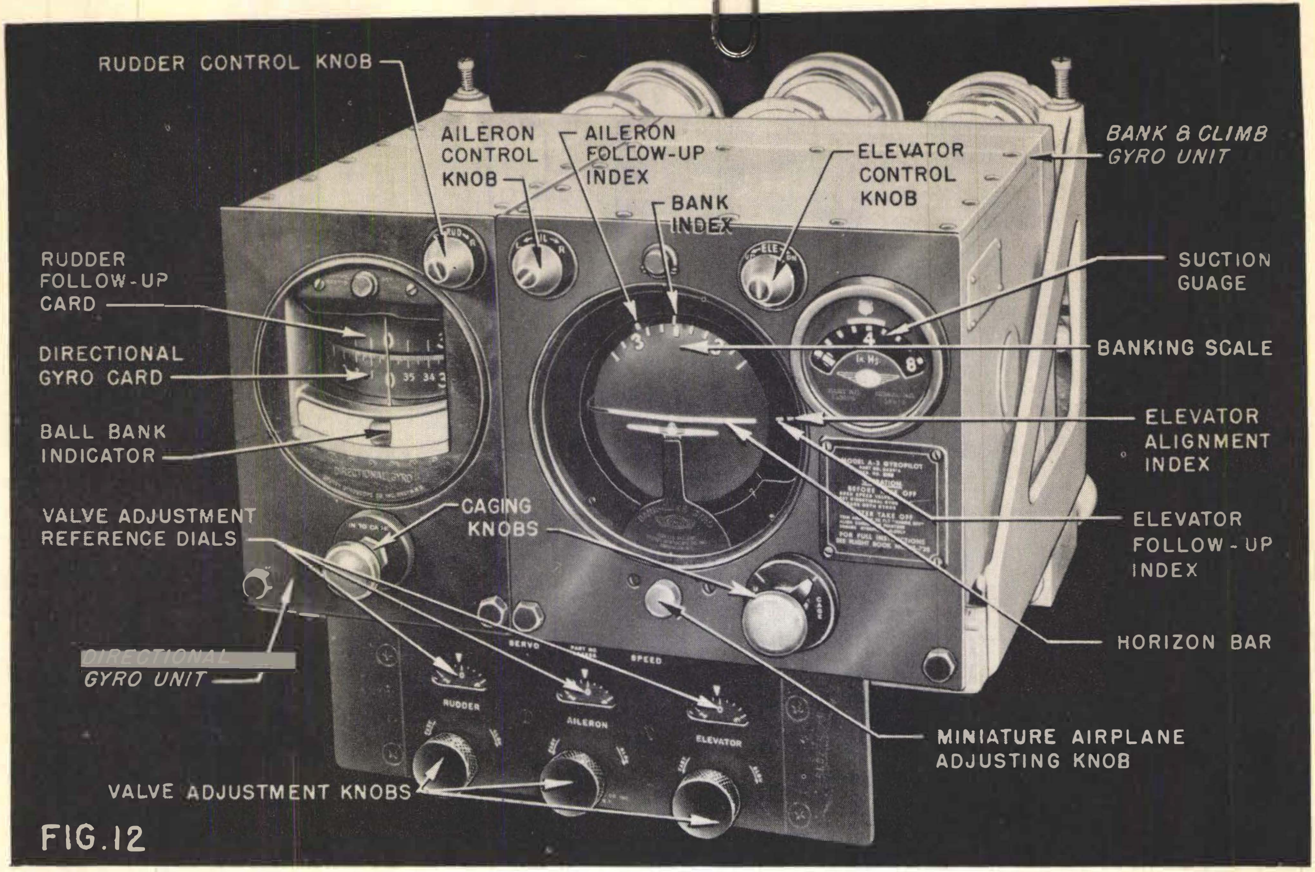
Since it is impossible to show follow-up movement in the diagram without altering the position of the air pick-offs,the sequence of operation is as follows:

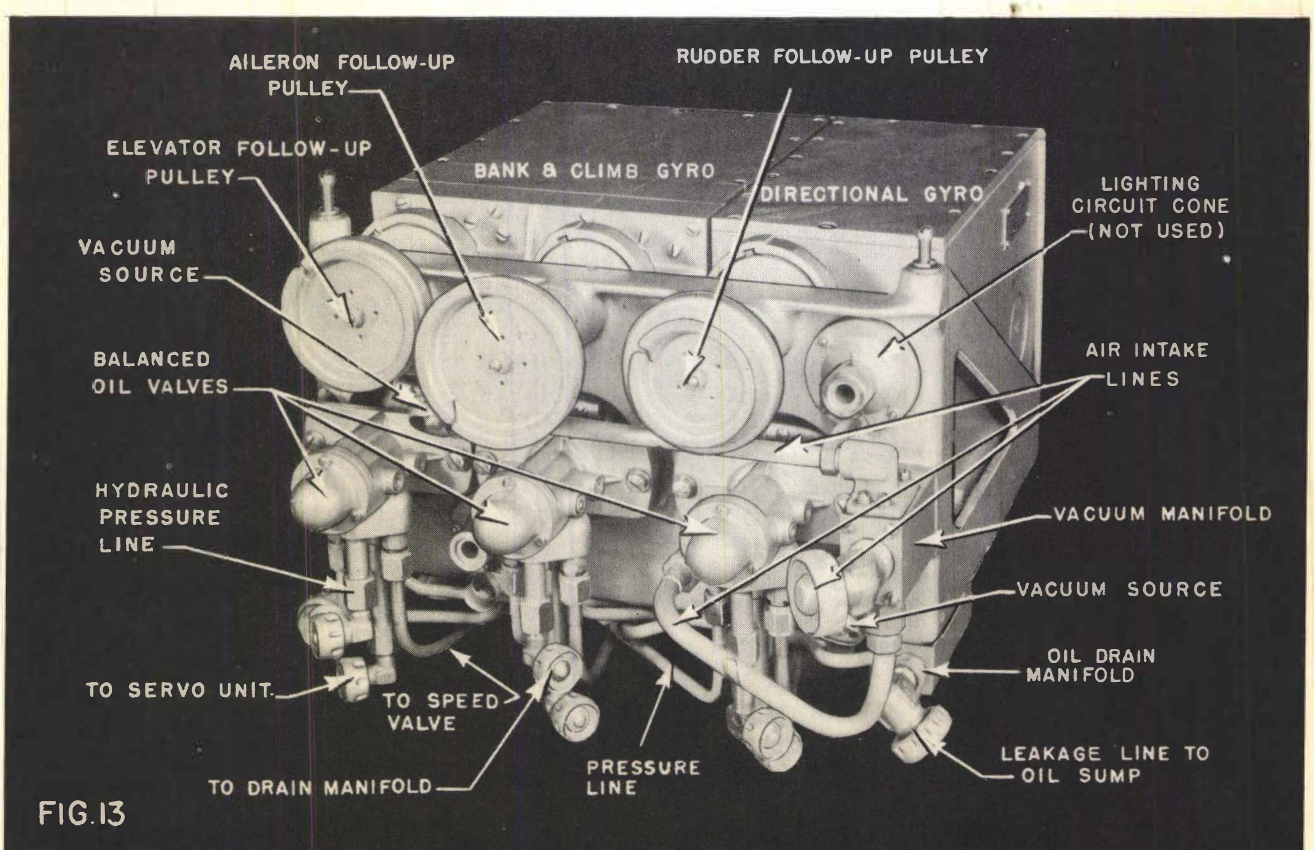
When the servo piston (L-L') moves to the right, the follow-up cable also moves and rotates the follow-up assembly against the pull of the balance spring (S). This moves (A) down and (A') up. When these ports reach a neutral position (both half open) the air relay and the balanced oil valve are centered and the servo piston movement away from the neutral position is stopped.

Now consider that the aileron movement which the servo has been producing has been bringing the aircraft back to level flight. As the airplane continues toward its normal attitude, the air pick-offs, which have been driven ahead of the gyro box, pass beyond the neutral point and begin to cause servo movement in the opposite direction. This is not opposite control, but merely removal of the control originally applied. The mechanism and its ratios are so arranged that the correct amount of control will be applied and also removed at the proper rate as the airplane returns to its normal attitude of flight.

The position of the air pick-offs can also be governed by the human pilot. This permits him to control the airplane by means of the automatic pilot mechanism.

The automatic pilot accessories are alsoshown in Fig. 10 and11. Part "T" is a suction regulator which keeps the vacuum for spinning the gyros and for the air pick-offs at the proper value, regardless of the speed of the suction pump. The vacuum, in inches of mercury,


RUDDER CONTROL KNOB
AILERON CONTROL KNOB
AILERON FOLLOW-UP INDEX
BANK INDEX
ELEVATOR CONTROL KNOB
BANK & CLIMB GYRO UNIT
RUDDER FOLLOW-UP CARD
DIRECTIONAL GYRO CARD
BALL BANK INDICATOR
SUCTION GUAGE
BANKING SCALE
ELEVATOR ALIGNMENT INDEX
ELEVATOR FOLLOW-UP INDEX
VALVE ADJUSTMENT REFERENCE DIALS
CAGING KNOBS
HORIZON BAR
DIRECTIONAL GYRO UNIT
MINIATURE AIRPLANE ADJUSTING KNOB
VALVE ADJUSTMENT KNOBS
RUDDER
AILERON
ELEVATOR
SERVO
SPEED
FIG. 12


AILERON FOLLOW-UP PULLEY
RUDDER FOLLOW-UP PULLEY
ELEVATOR FOLLOW-UP PULLEY
BANK & CLIMB GYRO
DIRECTIONAL GYRO
LIGHTING CIRCUIT CONE (NOT USED)
VACUUM SOURCE
BALANCED OIL VALVES
AIR INTAKE LINES
HYDRAULIC PRESSURE LINE
VACUUM MANIFOLD
VACUUM SOURCE
OIL DRAIN MANIFOLD
TO SERVO UNIT
TO SPEED VALVE
TO DRAIN MANIFOLD
PRESSURE LINE
LEAKAGE LINE TO OIL SUMP
FIG. 13

is indicated on the vacuum gauge (U). The hydraulic system reservoir (O) carries the reserve oil. Part (V)is a filter which prevents foreign matter from being forced into the system by the oil pump. Part (AB) is a valve which automatically regulates the oil pressure from the pump relief valve (N) and permits the oil to circulate back to the reservoir (Q) whenever the balanced oil valve (H) cuts off circulation to the servo unit. The oil pressure is indicated in the oil gauge (W). The servo relief valve shown at (P) permits the human pilot to overpower the automatic pilot even though the system is in operation. The speed control valves shown in (Y) serve to regulate the oil flow from each servo piston and, therefore, govern the rate of response with which the automatic pilot operates the rudder, ailerons and elevator. The by-pass valve (AC) in the servo unit is used to turn the automatic pilot on or off. This valve is connected by means of rods and bell-cranks to a control wheel located at the center of the upper control pedestal.

When the pilot desires to engage the automatic pilot hydraulic system with the general hydraulic system of the airplane, the knob and lever on the ON-OFF control wheel are squeezed together and pushed forward to the ON position. In so doing the plunger in the automatic pilot ON-OFF valve (AD) is depressed, allowing oil under pressure to flow to the automatic pilot units, and the by-pass valve (AC) in the servo unit is turned so that the oil will not flow through the by-pass tube. After the lever and knob are released,the lever acts as a brake to prevent the control wheel from creeping toward the OFF position. To disengage the automatic pilot hydraulic system, the knob on the wheel may be pulled aft against the action of the brake. However, the lever should be depressed to allow the wheel to be moved more freely.

The vacuum for the gyro control units is obtained from either the right or left vacuum pump as governed by the vacuum selector valve located on the sub-panel directly forward of the co-pilot.

Flight Instruments

Flight Indicator

An airplane pilot in flight has only one sense upon which he can depend with certainty--his eyesight. Under normal conditions, he judges the position of his airplane by watching the horizon and noting prominent landmarks on the earth. But storms wipe out all landmarks--wipe out the earth itself. The pilot loses all sense of direction and balance.

Until the invention of the modern flight instruments, flight under such conditions was impossible. Today the pilot has a substitute for the horizon of the earth: the "artificial horizon", sometimes called the "gyro-horizon". It is one of his most useful instruments. By means of a miniature airplane and a horizon bar, the pilot is given a visual picture of the attitude of his airplane at all times. He needs only to watch the horizon bar on his instrument to tell whether he is in level flight, climbing, gliding or banking.

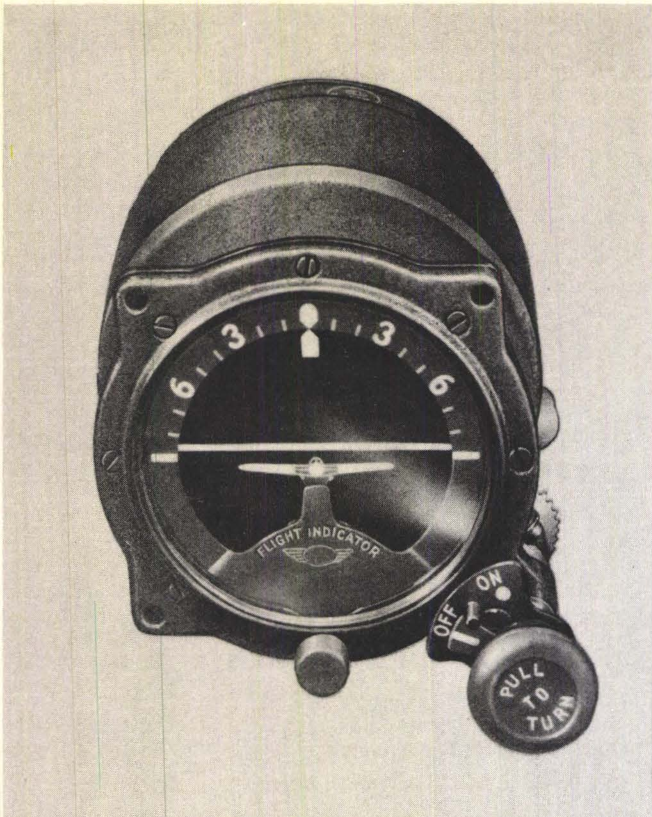


FIG.14

The miniature airplane is rigidly attached to the instrument panel, and so keeps the same position as the real airplane at all times. The horizon bar is attached to a gyroscope which tends to remain in a position with its axle vertical to the earth, regardless of the position of the airplane. Thus, when the airplane goes into a climb or glide, the horizon bar attached to the gyroscope drops below or rises above the miniature airplane on the face of the indicator. The pilot can immediately see to what degree his plane has changed from level flight. In the same manner, banks to either right or left are immediately shown on the indicator by a tipping of the horizon bar. The degree of bank is shown by a pointer and dial.

On the B-25 airplanes that are equipped with Automatic Flight Control Equipment, the flight indicator is located at the top center of the pilot's instrument panel. On airplanes equipped with the Sperry Auto-Pilot, it is placed just to the left of the Sperry A-3 equipment.

The Flight Indicator is fitted with a knob by means of which the instrument can be "caged", that is, put out of operation. This is necessary during acrobatics or similar maneuvers because the instrument is made to register no more than a 70 degree glide or climb, and no more than a 90 degree bank. If these limits are exceeded while the instrument is in operation, the gyroscope is likely to be thrown out of adjustment and give false readings.

Turn Indicator

The Turn Indicator (sometimes called a Directional Gyro is a mechanical compass giving a directional indication at all times,enabling the pilot to fly a straight course or to make exact turns. The indicator is not affected by any of the causes of magnetic compass errors, and so tells the pilot the exact direction in which the airplane is flying as well as the degree of turn made.

In principle and action, this instrument is similar to the Direction Indicator of the Sperry A-3 Auto Pilot. A vacuum-driven gyroscope mounted with its axle horizontal to the earth, is free to move to any position. The card is so attached to the gimbal rings that any turning of the airplane from the course for which the

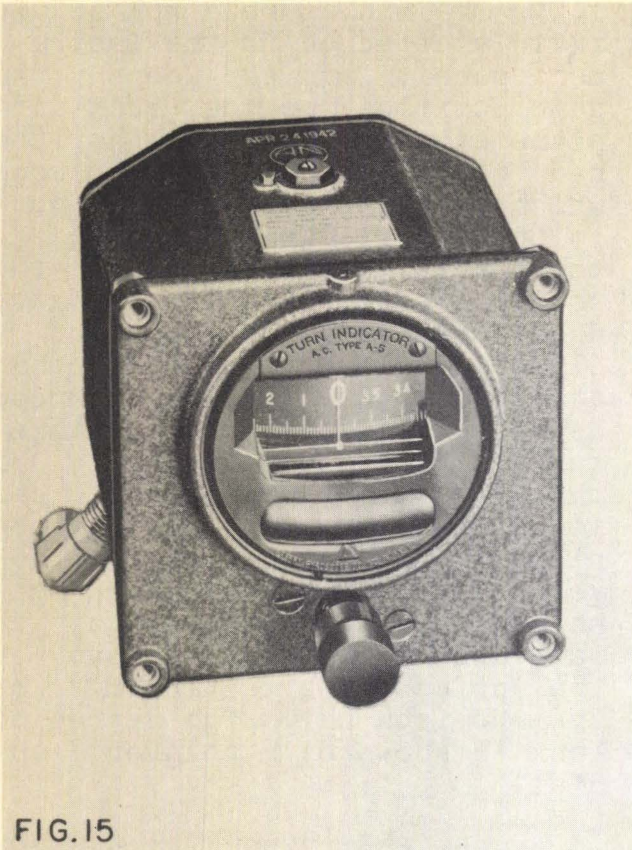


FIG.15

gyro has been set is shown on the indicator.

Unlike the magnetic compass, the turn indicator has no force to return it to a fixed direction. It is necessary to set the gyro from a magnetic compass, and occasionally to reset it. This is done by means of the caging knob underneath the dial. Pushing the knob engages it and adjusts the gyroscope horizontally. Pulling the knob out again frees the gyro for operation.

Air used to operate all flight instruments is drawn through separate filters attached to the case of each (Airplanes prior to AC 41-13039, B-25C, and AC 41-29848, B-25D), or is supplied through a single filter mounted at the rear of the panel (all subsequent airplanes).

Bank and Turn Indicator

The Bank and Turn Indicator is a combination instrument which aids flying when visibility is poor by giving the pilot an indication of his rate of turn, and telling him whether he is banking properly.

The Turn Indicator portion of the instrument is a vacuum-driven gyroscope rotating around a lateral axle within a frame (or gimbal) which is pivoted at front and back. When the airplane turns to right or left the gyroscope is forced off its straight path of motion. The result is that the gyroscope tends to turn laterally about its longitudinal pivot, thus moving the indicator pointer off center. The degree which the pointer is thrown off center is approximately proportional to

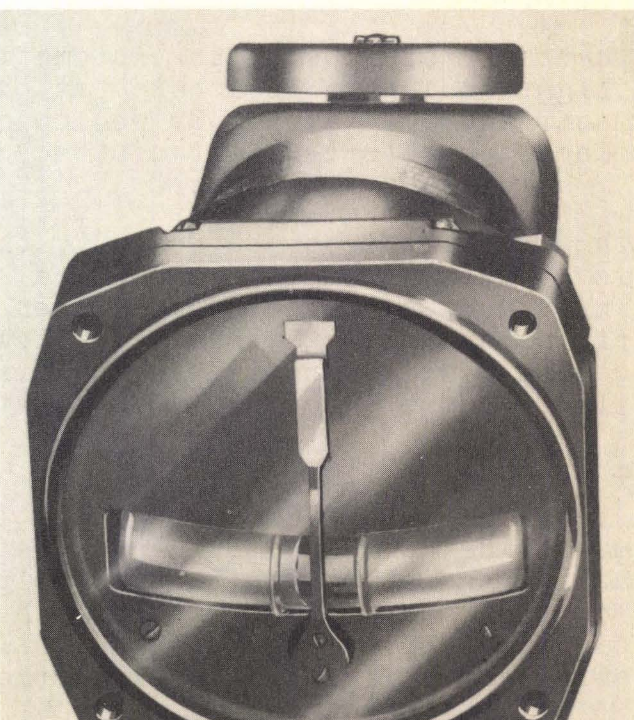


FIG.16 BANK & TURN INDICATOR

the rate of turn.

The Bank Indicator portion of the instrument is a simple form of pendulum with a black agate ball moving against the damping action of a liquid in a curved glass tube. When the airplane is making a banked turn, the ball is acted upon by two forces: (1) the force of gravity, tending to move it in a vertical direction, and (2) the centrifugal force, tending to move it horizontally. In a perfectly banked turn, the ball remains in the center of the tube. If the plane skids or slips in turning, the ball is thrown to one side of the glass tube.

Suction Gauge

Gyroscopic instruments will function properly only with the correct amount of vacuum. For that reason suction gauges are connected directly to the gyro units. In airplanes with A.F.C.E., the suction gauge is fitted to the Flight Indicator Gyro case and gives a reading of the suction actually present within the case, to drive the gyroscope.

The suction gauge consists of a case vented to the atmosphere within which is a very sensitive bellows type pressure capsule. The suction line is connected to this sealed capsule. Any change in the amount of suction in the line causes the bellows to contract or expand. This movement is transmitted to the pointer through a geared pinion and sector movement.

When the Sperry Auto-Pilot is used, a second suction gauge is included as a part of the automatic pilot unit.

AIRSPEED AND PITOT-STATIC INSTRUMENTS

Instruments indicating airspeed, altitude, and rate-of-climb operate by means of the Pitot-static tube extending in front of the leading edge of the right wing. The unit consists of two tubes leading from the Pitot head to the various air instruments:

(1) The Pitot tube, with its opening located at the very tip of the Pitot head, is open to the direct pressure of the air in flight. It delivers dynamic (moving) air pressure to the fitting at the back center of the Airspeed Indicator.

(2) The Static tube is open to the static (still) air through small holes around the sides of the Pitot head. It delivers air pressure to the Airspeed Indicator, the Altimeter, and Rate-of-Climb Indicator.

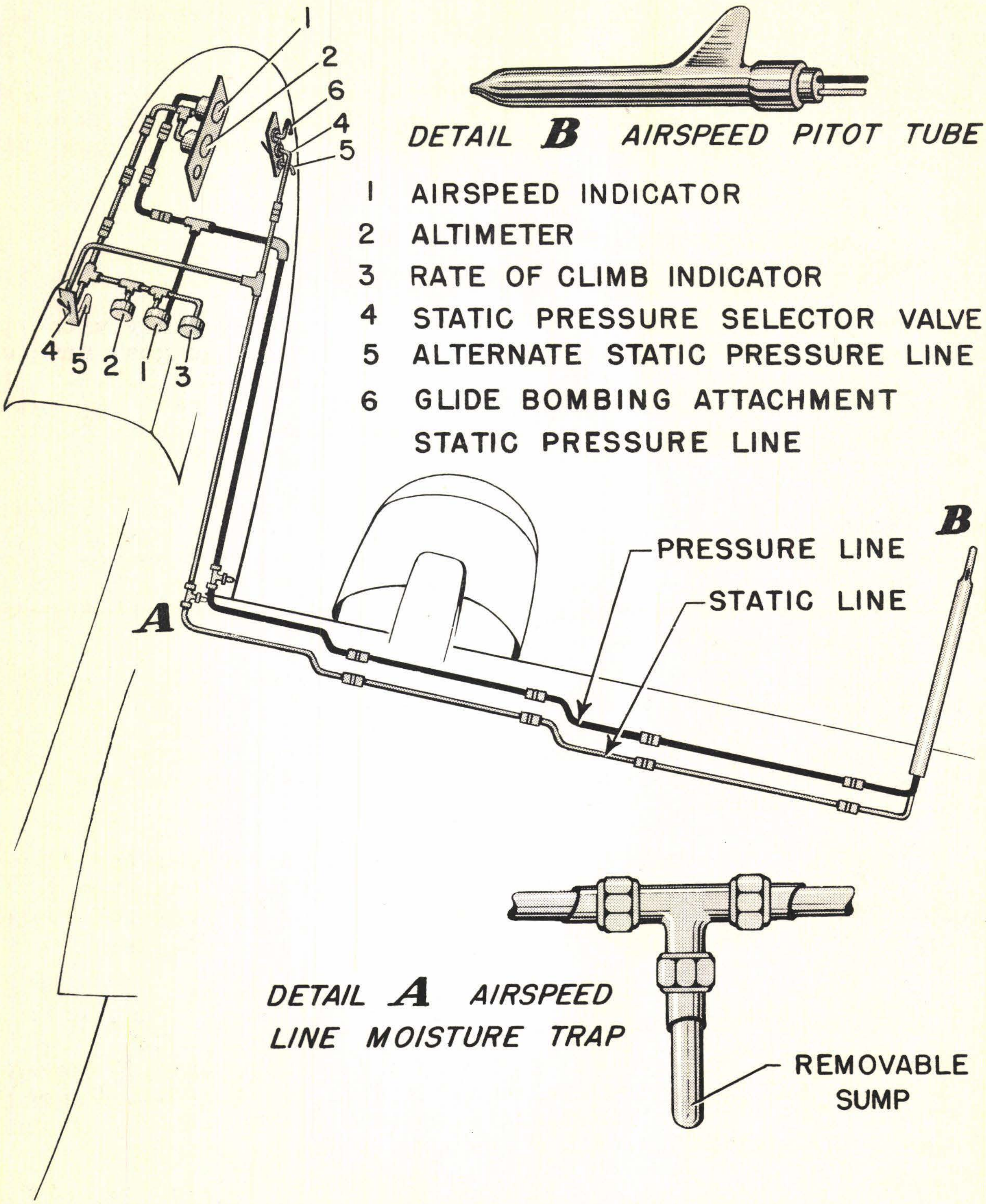


FIG. 17 AIRSPEED SYSTEM INSTALLATION

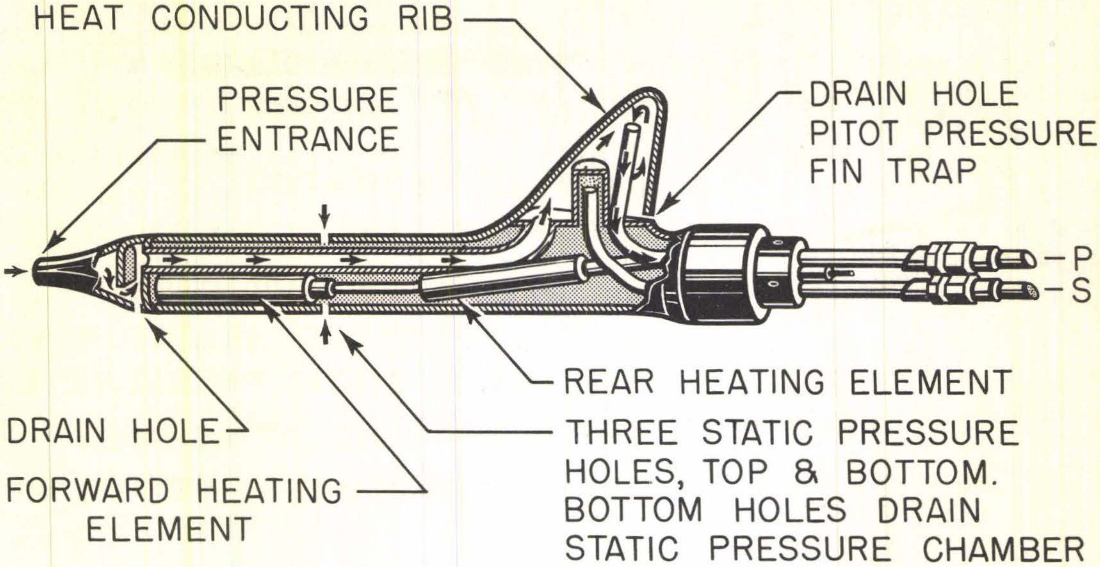


FIG. 18 PITOT-STATIC TUBE

Static Selector Valve

An alternate source of static pressure is provided for use in case of failure of the Pitot-Static line. The static Selector Valve, located at the left side of the pilot's compartment, makes it possible to draw static air from either the Pitot system or from a tube vented to the cockpit.

The static pressure within the fuselage is seldom the same as that at the Pitot head;consequently instruments will not give better than approximate readings when connected to the "Alternate" source. It should never be used except in emergencies.

Glide Bombing Attachment Static Selector Valve*

A Static Selector Valve located in the bombardier's compartment provides an alternate static air source for the Glide Bombing equipment. (Due to the confidential nature of the Glide Bombing equipment, no description of the instrument can be included.)

*Note: Bombardier's selector valve only on B-25C airplanes AC 41-12817 and subsequent, and B-25D airplanes AC 41-29848 and subsequent.

When Glide Bombing equipment is not installed, the bombardier's selector valve MUST be kept in the ALTERNATE position. If this is not done, instruments operated by static pressure will not function properly.

Pitot Head Heater

An electrical heater, controlled from the pilot's switch panel, is used to prevent icing of the Pitot head.

The heater is to be used ONLY when freezing conditions are encountered in flight. It may be turned on MOMENTARILY for checking purposes while the airplane is on the ground. Otherwise the heater MUST BE KEPT TURNED OFF.

Airspeed Indicator

There are several uses for the Airspeed Indicator:

(1) To warn the pilot when the airplane is nearing its stalling point.

(2) To indicate the speed of the airplane.

(3) To determine approximate distance flown.

Principle of the Airspeed Indicator is the measurement of differential pressure. The indicator is made up of a pressure-sensitive metal diaphragm connected to the Pitot (or pressure) line. The surrounding instrument case is connected to the static (still or atmospheric) line. Pressure carried through the Pitot line moves the diaphragm, thus turning the indicator pointer. The difference between static and Pitot pressure is measured as an indication of air speed.

As the airspeed indicator measures both the pressure and density of the air, changes from standard conditions of atmospheric pressure and temperature have their effect on the readings. In order to obtain what is called "true air speed", calculations must be made with the help of a "compensation chart", taking into consideration temperature and density changes.

Altimeter

Safe Flying depends on knowing the height of the airplane above the ground. For this information, the pilot depends on the altimeter, an instrument similar to the aneroid barometer. A pressure-sensitive metal diaphragm, pumped partly free of air is placed in the sealed instrument case. This case is connected to the static pressure line of the Pitot system. Changes in atmospheric pressure allow the diaphragm to expand or contract, and these changes are transmitted by springs and levers to the indicator pointer. These pressure changes are used as indications of height above sea level.

Atmospheric pressure depends on the density of the air, which may vary with changing weather conditions. Therefore, it is frequently necessary to adjust the instrument in flight to compensate for changed air density. This adjustment is made on a barometric scale graduated in inches of mercury, and visible through a small window in the instrument dial. On the basis of reports from ground stations, the pilot turns the adjustment knob until the barometric scale indicates the proper pressures, as reported. This automatically changes the length of the link arm regulating the travel of the pointers so that the altitude indicator will be correct for the existing conditions.

A temperature compensator attached to the sensitive diaphragm automatically compensates for temperature variations.

B-25 airplanes are equipped with two Sensitive Altimeters, one at the left of the pilot's panel and one on the bombardier's instrument panel. Both are of the three-pointer type, indicating hundreds, thousands, and tens of thousands of feet, as a clock indicates seconds, minutes, and hours.

Rate of Climb Indicator

The Rate of Climb Indicator (also called Vertical Speed Indicator) shows the rate at which the airplane is changing altitude, either up or down. It is used both as an aid to holding the airplane in level flight and to maintaining the correct speed of ascent or descent in taking off, landing, or traveling through an overcast.

Like the airspeed indicator, the Rate of Climb Indicator operates on the principle of differential pressure measurement. The atmospheric pressure from the static tube is introduced directly to the inside of sensitive metal diaphragm capsule. This aneroid diaphragm, in turn, is vented to the instrument case through a capillary leak tube which allows the air to pass slowly between the diaphragm capsule and the instrument case.

In level flight, the pressure within the instrument case is the same as that in the diaphragm. As soon as the airplane begins to climb, the barometric pressure within the capsule drops, allowing the diaphragm to contract. The speed with which the capsule contracts or expands is indicated on the instrument pointer and is read as vertical speed in feet per minute. As the pressure within the diaphragm drops, the heavier air in the instrument case leaks slowly through the capillary tube into the diaphragm, in an attempt to equalize the pressures. This equalization cannot be achieved fully until the airplane is again in level flight.

Descent of the airplane results in immediate expansion of the diaphragm, followed by a slow flow of air from diaphragm to instrument case.

A setting knob on the front of the instrument makes possible adjustment of the dial pointer. The instrument automatically compensates for altitude and temperature.

ENGINE INSTRUMENTS

Autosyn Systems

Except for the cylinder head temperature indicator, all of the engine instruments in the B-25C airplane are of the remote-indicating Autosyn type.

Autosyn is a trade name given to a system for transmitting mechanical motion electrically to a distant point. Each system is made up of two instruments, a Transmitter and an Indicator (or Receiver) connected by wires. The electrical elements of both Transmitter and Indicator are alike, the two fundamental parts being the rotor which revolves, and the stator, which stands still.

The system applies the principle of self-synchronous motor operation, in which the motion of one motor is duplicated in another motor. The two motors operate in exact synchronism, the rotor of one motor following the least motion of the rotor in the other. Simple electrical wiring between the two units eliminates all mechanical connections.

Although seldom operating in continuous rotation, the units are known as "motors" for the purpose of explanation.

For an operating source of power, 26 volt, 400 cycle alternating current from the airplane's inverter is used.

Operation

A Bourdon tube or pressure diaphragm rotates the transmitter rotor to various positions within the stator by means of a sector gear. This change in rotor position disturbs the voltage and phasing balance of the mechanism, setting up electrical impulses to the Indicator. The impulses cause the same amount of movement in the Indicator rotor, which is connected to the Indicator pointer. Thus, any mechanically-caused movement of the transmitter rotor is transmitted by electrical impulses and shown on the indicating dial at the instrument panel.

Engine instrument indicators are of the dual type, giving readings for both right and left engines on one dial. The dual indicators consist of two "Autosyns" mounted in tandem, each of which is operated independently of the other by its own transmitter. The rotor shaft of the front "Autosyn", connecting to the dial pointer, is hollow. An extension shaft from the rear "Autosyn" passes through it and carries the second pointer on its outer end.

The pointers are marked "R" and "L". The first gives the reading for the right-hand engine, and the second the reading for the left.

All engine indicators are grouped at the right-hand side of the pilot's instrument panel, in front of the co-pilot's seat.

1. TACHOMETER TRANSMITTER
2. FUEL PRESSURE TRANSMITTER
3. OIL PRESSURE TRANSMITTER
4. MANIFOLD PRESSURE TRANSMITTER
5. OIL TEMPERATURE TRANSMITTER (B-25C ONLY)
6. CYLINDER-HEAD TEMPERATURE THERMOCOUPLE
7. OIL "Y" DRAIN
8. ELECTRICAL JUNCTION BOX
9. THERMOCOUPLE INDICATOR

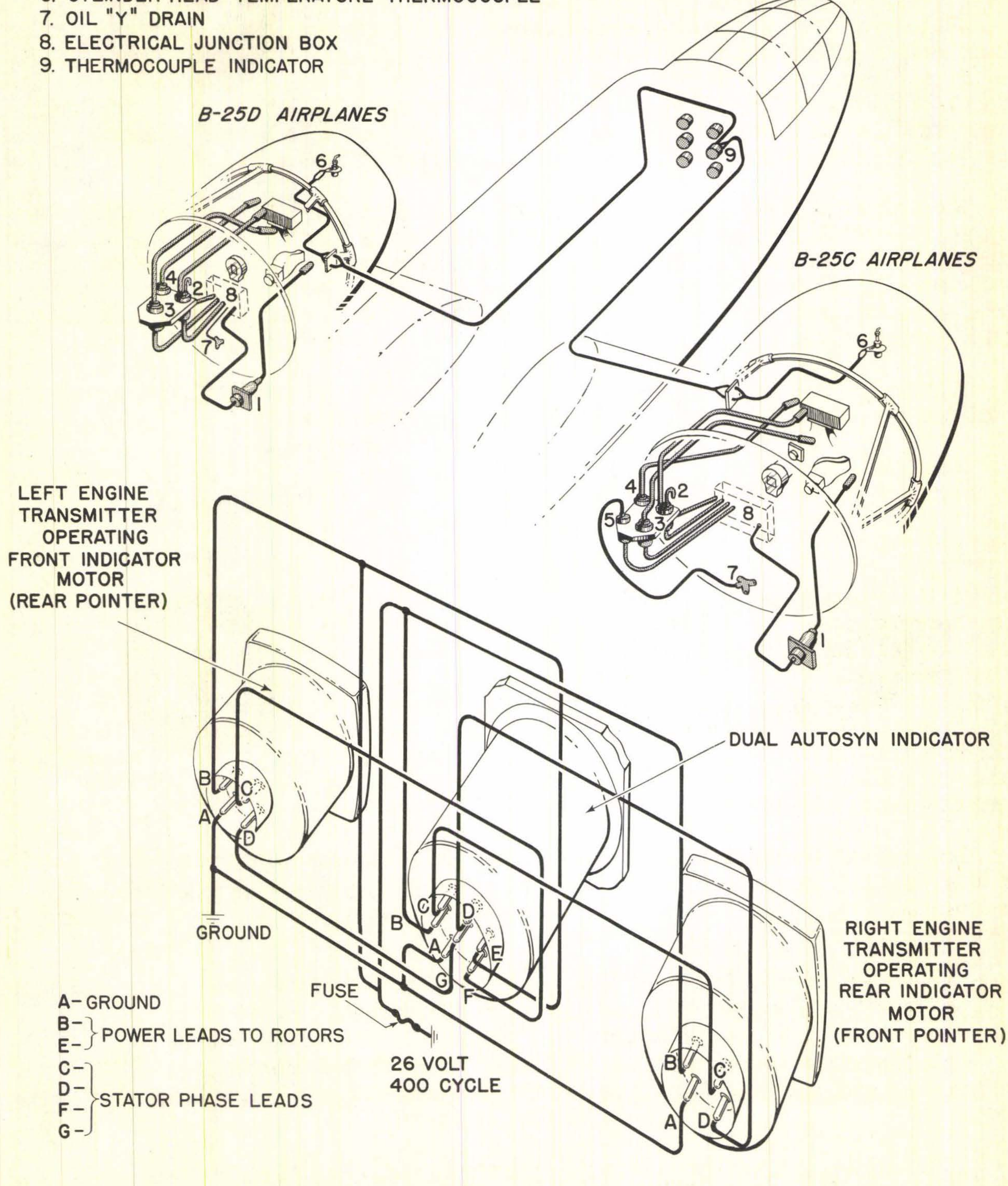
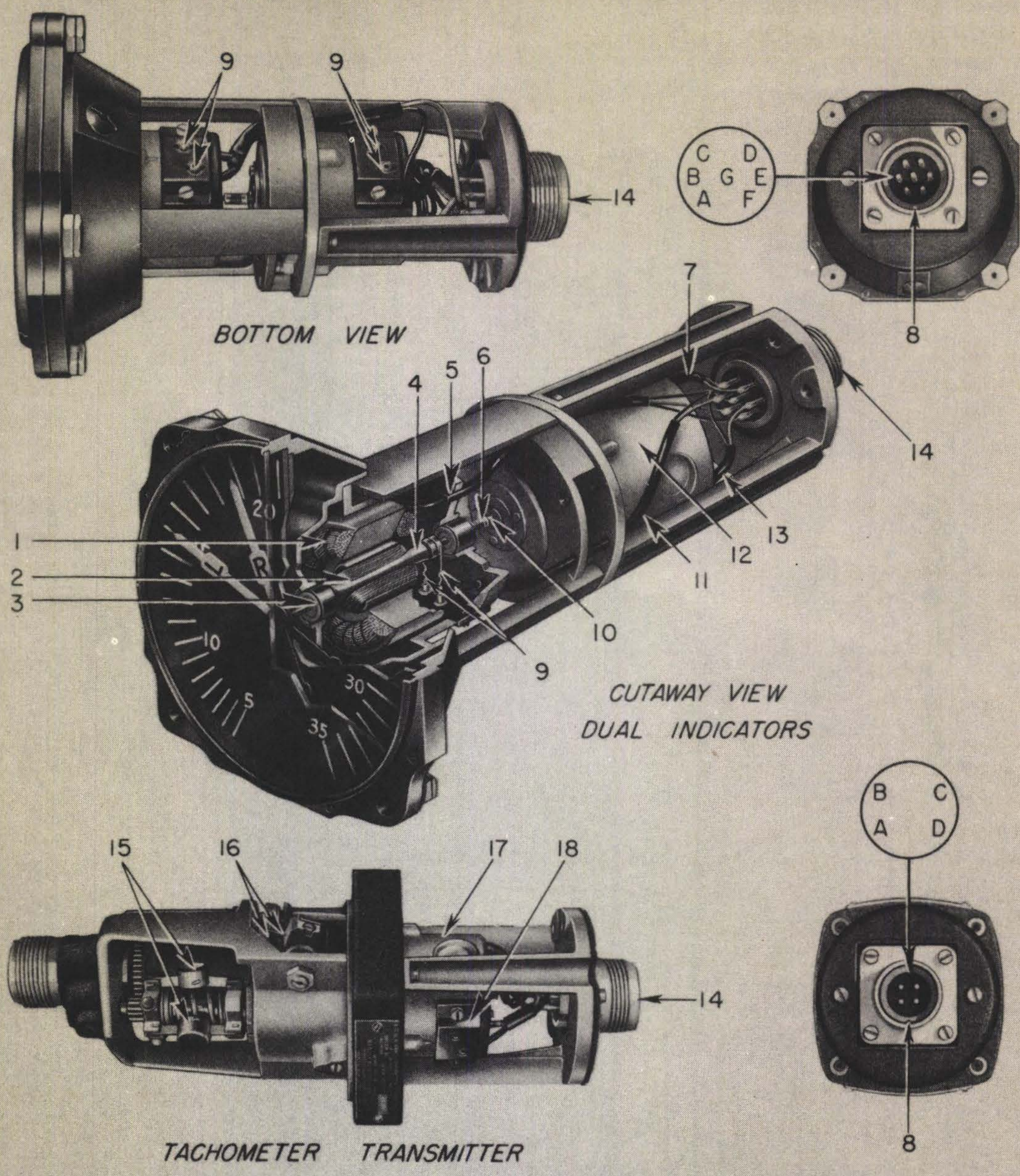


FIG. 19 ENGINE INSTRUMENTS INSTALLATION



1 STATOR (FRONT MOTOR)
2 ROTOR (FRONT MOTOR)
3 BALL BEARING
4 SHAFT (FRONT MOTOR)
5 STATOR LEADS (FRONT MOTOR)
6 SHAFT CLUTCH SPRING
7 STATOR LEADS (REAR MOTOR)
8 CONNECTOR PLUG KEY
9 COMMUTATOR BRUSHES
10 SHAFT (REAR MOTOR)
11 ROTOR LEADS (FRONT MOTOR)
12 REAR MOTOR
13 ROTOR LEADS (REAR MOTOR)
14 CONNECTOR PLUG
15 CENTRIFUGAL FLYWEIGHTS
16 ROTOR ACTUATING LEVERS
17 TRANSMITTER MOTOR
18 ROTOR COMMUTATOR BRUSH MOUNT

FIG. 20 AUTOSYN DUAL INDICATOR AND TRANSMITTER

Autosyn Type Instruments

Fuel, Oil and Manifold Pressures

Fuel, oil, and manifold pressures are carried from the carburetor, the engine-driven oil pumps, and the supercharger, respectively, through 1/4-inch dural lines to the Autosyn transmitters, where the mechanical motion of Bourdon tubes (fuel and oil) and a diaphragm (manifold) rotates the transmitter rotors.

Oil Temperature

On the B-25C, oil temperature is carried from the oil "Y" drain to the Autosyn transmitter by means of a vapor-filled capillary line and Bourdon tube.

The oil temperature instrument used on the B-25D airplanes is NOT of the Autosyn type. Instead, an electrical resistance bulb is located in each oil "Y" drain. Temperature changes are carried by electrical wiring directly to a dual indicator on the pilot's instrument panel. (See "Free Air Temperature Indicator" for principle of operation).

Tachometer

Indication of the engine RPM is carried by means of a flexible shaft connected at one end to a tachometer adapter at the engine fuel pump and at the other end to a centrifugal (governor-like) element in the Autosyn transmitter. The centrifugal force of the governor weights, as they whirl, causes a sleeve on the shaft to slide to different positions at each speed. Movement of the sleeve shifts the transmitter rotor position by means of a lever action. The rotor movement, in turn, is transmitted electrically to the Autosyn indicator unit.

Autosyn Transmitter Locations

Fuel, oil, manifold pressure, and oil temperature transmitters are mounted together on one panel at the left front of both nacelles. The tachometer is mounted by itself at the right side of both nacelles. All are shock mounted.

Electrical Instruments Not of Autosyn Type

Cylinder-Head Temperature

The only engine instrument not of the Autosyn type is the cylinder-head temperature indicator (Thermocouple Indicator), which is connected to the No. 1 cylinder-head of each engine by means of thermocouple leads.

Two wires of different metals (iron and constantan) are fastened at one end to a copper adapter (spark-plug gasket) and, at the other end, each is connected to a terminal of the temperature indicator. Although voltage generated by heat is very small, it is in dir-

BATTERY DISCONNECT SWITCHES OFF - NO INDICATION

LANDING GEAR DOWN & LOCKED FLAPS 30°

LANDING GEAR BEING RETRACTED FLAPS 15°

LANDING GEAR UP & LOCKED FLAPS UP

LANDING GEAR DOWN-NOT LOCKED FLAPS 15°

LANDING GEAR DOWN & LOCKED FLAPS 45°

FIG. 21 LANDING GEAR AND FLAP POSITION INDICATOR

ect proportion to temperature change, and can be measured by a sensitive millivoltmeter. Because of the dissimilar materials of the wires, the generation of electrical potential when heat is applied will be greater in one wire than in the other. This difference in electrical potential or voltage is measured by the indicator and shown on the instrument dial in terms of degrees centigrade. Connection bolts at the back of the instrument, and lugs on the thermocouple leads are matched so that proper connections can be made easily. Do not attach the large lug to the small bolt, and do not attempt to force the small lug on the large bolt.

Instruments are calibrated by the manufacturer to the length and diameter of the couples or wires. Couples should never be cut of used with meters calibrated for another length.

MISCELLANEOUS INSTRUMENTS

Fuel Level Gauge (Liquidometer)

One Liquidometer, five-position fuel-level gauge on the right center portion of the pilot's instrument panel gives readings for four main wing fuel tanks. Any one of the tanks can be selected for a reading by means of the combination dial change and selector switch handle. The fifth position is not connected.

Beginning with airplanes serial number AC 41-12817 and subsequent B-25C's and AC 41-29848 and subsequent B-25D's, a group of three auxiliary fuel tanks will be added in each wing. A separate Liquidometer gauge of the dual type will indicate the levels of these two groups of auxiliary tanks.

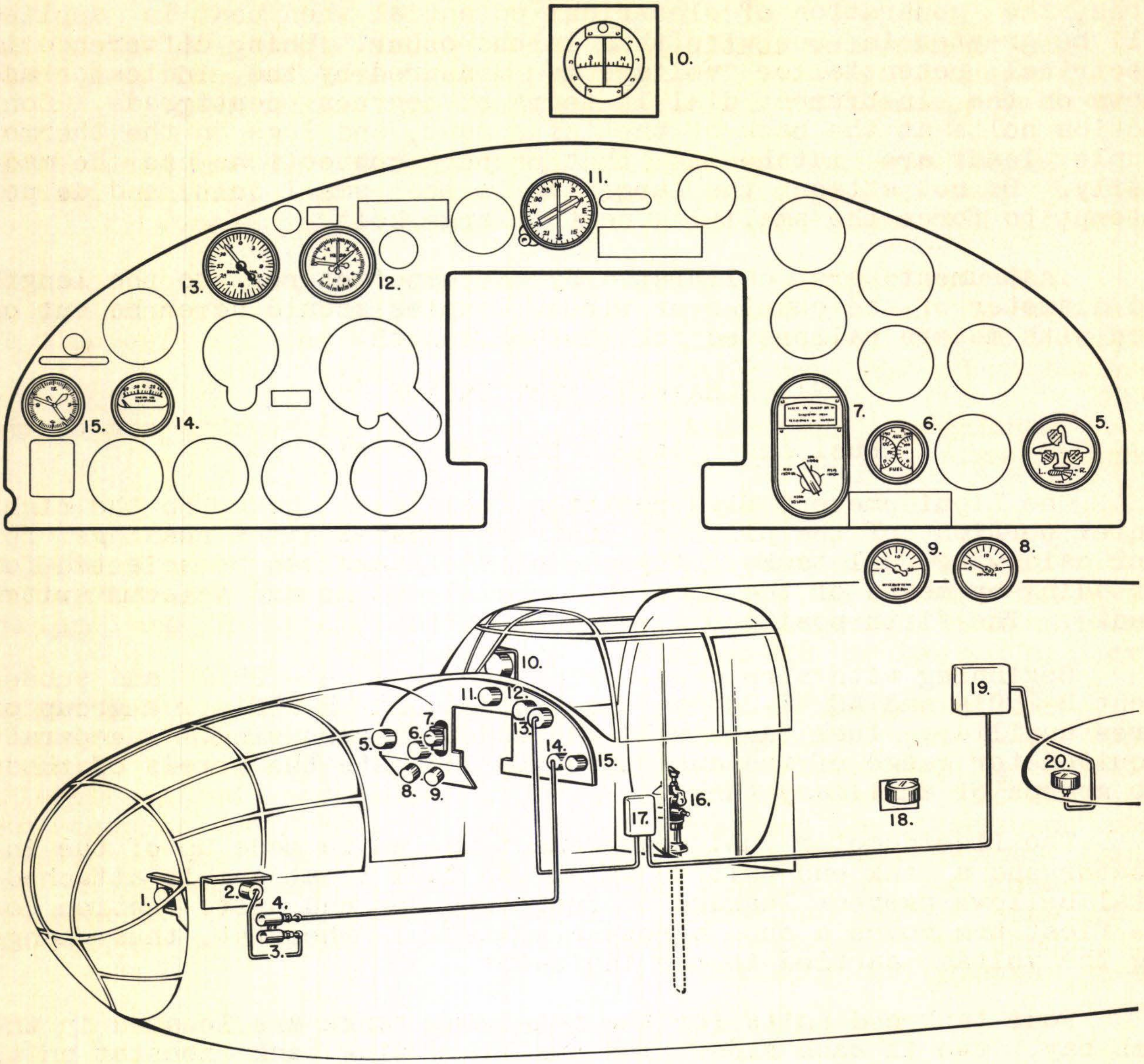
The Liquidometer fuel measurement system is made up of the indicator and a tank end unit to which the tank float arm is attached. Metal bellows prevent leakage of fuel into the end unit. Action of the float arm moves a shoe across a resistance rheostat, thus changing the voltage carried to the indicator.

Four tank end units for the main wing tanks are located in the bomb bay, two in each side. The auxiliary wing tank rheostat units connect to the bottoms of the tanks and are located high in the forward part of the nacelle wheel-wells.

Landing Gear and Flap Position Indicator

One Selsyn landing gear and flap position indicator located on the pilot's panel shows the position of landing gear wheels and flaps. The indicator has four separate indicating elements, one for each wheel and one for the flaps. Each is operated by a separate transmitter.

Each of the four elements of the indicator consists of a laminated ring of ferro-magnet material on which three windings are equally spaced. A polarized armature in the center of this ring is free to rotate. A disc carrying the figure of a wing flap or wheel is fasten-



LEGEND

1. BOMBARDIER'S MAGNETIC COMPASS
2. BOMBARDIER'S FREE AIR TEMP. INDICATOR
3. BOMBARDIER'S FREE AIR TEMP. BULB
4. PILOT'S FREE AIR TEMP. BULB
5. LANDING GEAR & FLAP POSITION INDICATOR
6. FUEL LEVEL INDICATOR (AUXILIARY TANKS)
7. FUEL LEVEL INDICATOR (MAIN TANKS)
8. BRAKE PRESSURE GAGE
9. HYDRAULIC PRESSURE GAGE
10. PILOT'S MAGNETIC COMPASS
11. REMOTE INDICATING COMPASS-(SER. NO'S. B-25C, AC42-32233 & B-25D, AC41-30148 & SUBSEQUENT ONLY)
12. ACCELEROMETER
13. PILOT'S RADIO COMPASS INDICATOR
14. PILOT'S FREE AIR TEMP. INDICATOR
15. PILOT'S CLOCK
16. DRIFT METER (NAVIGATOR'S COMPARTMENT)
17. PILOT'S RADIO COMPASS CONTROL
18. APERIODIC COMPASS
19. NAVIGATOR'S RADIO COMPASS CONTROL
20. NAVIGATOR'S RADIO COMPASS INDICATOR

FIG. 22 MISCELLANEOUS INSTRUMENTS INSTALLATION

ed to the armature shaft so that, as the shaft turns, the figure can be seen through an opening in the indicator dial.

The transmitter consists of a resistance winding on which two spring contacts operate. The spring contacts are fastened to a shaft rotated by movement of the airplane flaps or landing gear.

Yellow warning flags show on the indicator when any part of the landing gear is not locked down. As soon as the landing gear is locked in DOWN position, the flags disappear out of sight.

Main landing gear Selsyn transmitters are located on the forward side of the landing gear brace; the nose wheel transmitter is attached to the forward wall of the wheel-well; and the flap unit is located at the left-rear corner of the bomb bay.

Setting of the indicator is done by adjusting the arm on the transmitter.

Free Air Temperature

There are two Free Air Temperature Indicators, one located on the pilot's panel and one on the bombardier's panel. The bulb units (one for each instrument) are mounted on the outside of the fuselage skin (left side) of the bombardier's compartment.

The instrument is of the "Wheatstone Bridge" electrical resistance type, energized by 24 volts direct current from the airplane's battery. A temperature-sensitive wire (usually platinum) fixed in the bulb unit forms the third leg of the Wheatstone Bridge circuit. When the electrical resistances of each side of the circuit are equal, no current will flow through the indicator and the pointer will remain at the balance point on the dial. But a change in the resistance of the bulb-wire, due to a change in air temperature, will upset the resistance balance and current will flow through the meter, causing the pointer to move.

Hydraulic and Brake Pressure Indicators

Two pressure gauges of the Bourdon tube type, one to show the hydraulic system pressure, and one to show the hydraulic brake pressure are located in the far right-hand side of the pilot's panel. Lines to the gauges lead from snubbers located in the top forward part of the nose-wheel well. The Brake and Pressure Gauges give readings of pressure in the Brake and Pressure Accumulators.

Snubbers with a double damping action are required in lines to the gauges because of the high hydraulic pressure (1200 pounds).They serve to lessen the force on the sensitive Bourdon tubes to prevent damaging them.

Drift Meter

The Drift Meter is a navigation instrument used to find what amount and in what direction the airplane is drifting from its course

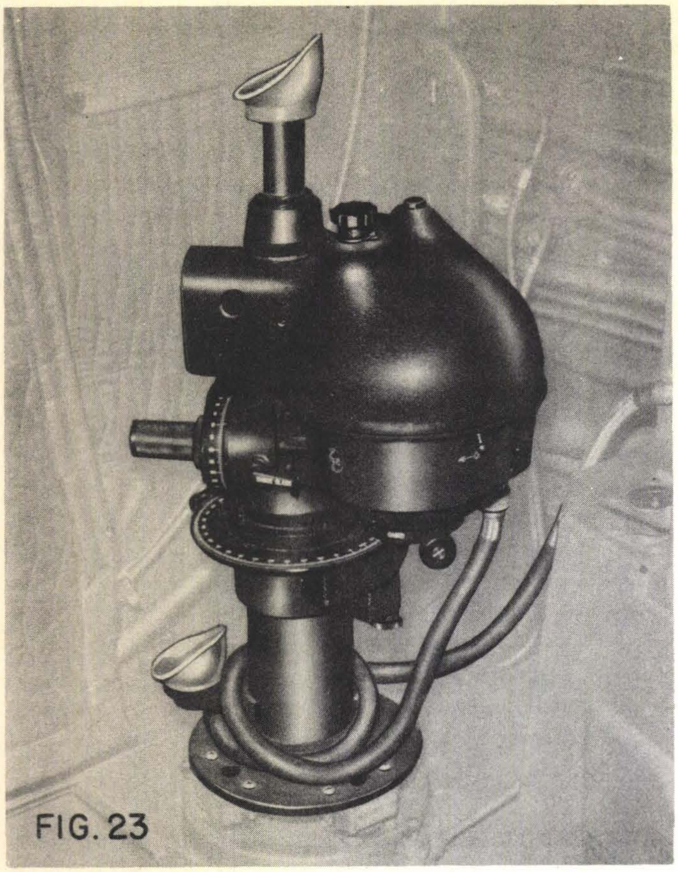


FIG. 23

as a result of cross winds.

Sighting through a telescope eye-piece, the observer notes the direction of what appears to be a pattern of flow of objects on the earth surface. This will be readily understood by anyone who has leaned from a fast-moving automobile and has looked at the ground as it seemed to pass beneath him.

A round pane of glass, marked off in degrees around its edge, and with parallel lines marked across its face, is fixed between the eye-piece and the earth. The observer rotates the glass pane until the pattern of earth flow appears to be moving parallel to the lines marked on the glass. By noting how many degrees he has turned the glass he is able to tell how many degrees off course the airplane has drifted. Such is the simple, basic principle of the Drift Meter.

In order to make possible drift readings during pitching and rolling motions of the airplane, an electrically operated gyroscope holds the lined glass pane level with the earth. The gyroscope is run by power from the inverter at a speed of approximately 10,600 RPM.

The Drift Meter is located in the forward, right-hand section of the navigator's compartment, directly over the hydraulic accumulators.

When not in use, or during maneuvers, the Drift Meter gyro must be kept caged to prevent damage to it. The caging device is attached to the bottom of the gyro housing.

Magnetic Compasses

There are three magnetic compasses, one on the pilot's instrument panel, one forward of the bombardier's instrument panel, and one at the left side of the navigator's compartment.

Pilot's and bombardier's compasses are of the rotating-card type. The one used by the navigator is an aperiodic compass (a horizontally placed compass with a pointer instead of a card). Readings on the aperiodic compass are taken by means of parallel sighting lines across the face of the instrument. These sighting lines can be changed by rotating the glass cover of the instrument. Because more

effective damping is possible on this type of compass, there is little over-swing or vibrating movement of the pointer.

Radio Compass Indicator

One radio compass indicator is located on the Pilot's instrument panel, another is placed in the Navigator's compartment. (Operation of these indicators is fully explained in connection with the radio system).

Accelerometer

Recent B-25C and B-25D airplanes are equipped with accelerometers to indicate the vertical forces exerted on the airplane, as when pulling out of a dive. The instrument, located on the pilot's instrument panel, contains pendulum-like weights held at top and bottom by springs. Any change in the vertical speed of the airplane causes the weights to move out of their central position against the force of the springs. The amount of movement, as indicated on a pointer, is in proportion to the rate of change in vertical speed. When the ship is at rest, the pointer shows a reading of +1 due to normal gravitational pull. Two record markers remain at the maximum positive and negative accelerations until reset.

EQUIPMENT LIST: B-25C and B-25D

Pilot's Station Instrument Equipment

*1	Pilot Director Indicator (On airplanes with AFCE only)		Spec. C24580-D
	Pilot Director Indicator (Provisions only on airplanes equipped with A-3 Automatic Pilot)		
*1	Turn Indicator	Type A-5	Spec. 27963
*1	Flight Indicator	Type C-7	Spec. 27962
*1	Altimeter	Type C-12	Spec. 27957
*1	Airspeed Indicator	Type D-7	Spec. 27953
*1	Bank and Turn Indicator	Type A-8	Spec. 27955
*1	Rate of Climb Indicator	Type C-2	Spec. 94-27967
*1	Clock	Type A-11	Spec. 27970
*1	Suction Gauge	Type F-3	Spec. 27923
*1	Compass	Type B-17	Spec. 27815
*2	Radio Compass Indicator	Type 1-81-A	Spec. H41D7019
*1	Free Air Temperature	Type C-11	Spec. 94-27949
*1	Hydraulic Pressure Gauge	Type E-4	Spec. 94-27922
*1	Manifold Pressure Gauge (Dual)	Type D-8	Spec. 94-27936
*1	Fuel Pressure Gauge (Dual)	Type C-14	Spec. 27935
*1	Oil Pressure Gauge	Type B-9	Spec. 27934

Note: * Indicates Government-Furnished Equipment (G.F.E.), installed at the factory.

*1	Oil Temperature Gauge (Dual)	Type A-22	Spec. 27946 (B-25C only)
*1	Oil Temperature Gauge (Dual)	Type A-24	Spec. 27998 (B-25D only)
*1	Thermocouple Indicator (Dual	Type B-11	Spec. 94-27971
*1	Tachometer Indicator (Dual)	Type E-10	Spec. 27972
1	Fuel Level Gauge Liquidometer	EA49-4	Spec. 27737-F
1	Position Indicator, Landing Gear and Flaps, General Electric (24-volt) GE8DJ4PAL		
1	Brake Pressure Gauge Similar to Type E-4		Spec. 94-27922
1	Needle Valve	Parker	No. 4561-1-1/8-D
*1	Accelerometer (on Airplanes with A-3Automatic Pilot)	Type B-3	(Spec. 94-27960 (or (AN 5745

Bombardier's Station Instrument Equipment

*1	Altimeter	Type C-12	Spec. 27957
*1	Airspeed Indicator	Type D-7	Spec. 27953
*1	Free Air Thermometer	Type C-11	Spec. 94-27949 (B-25C only)
*1	Free Air Thermometer	Type C-10	Spec. 94-27948 (B-25D only)
*1	Compass	Type B-16	Spec. 94-27807

Navigator's Station Instrument Equipment

*1	Compass	Type D-12	Spec. 27825
*1	Drift Meter	Type B-3	Spec. 27796
*1	De-Icer Pressure Gauge	Type G-2	Spec. 27924

Camera Station Instrument Equipment

1	Vacuum Shut-Off Valve	Parker	No. 8PVGG-D

Engine Compartment Instrument Equipment

*2	Vacuum Pumps	Type B-12	Spec. 28391
*2	Suction Relief Valve	Type B-12	Spec. 28391
*2	Safety Valve (De-Icer System)	Type B-12	Spec. 28391
*2	Oil Separators	Type B-12	Spec. 28391
*2	Check Valve 1/2 I.P.		Spec. 27894
*2	Transmitter (Manifold Press.)	Type D-8	Spec. 94-27936
*2	Transmitter (Fuel Press.)	Type C-14	Spec. 27935
*2	Transmitter (Tachometer)	Type E-10	Spec. 27972
*2	Transmitter (Oil Temp.)	Type A-22	Spec. 27946 (B-25C only)

*2	Bulbs (Oil Tem.) (Elect. Resist.)	Type A-24	Spec. 94-27321 (B-25D only)

Airspeed System Equipment

Location	Equipment
Pilot's Panel	Airspeed Indicator Altimeter. Rate of Climb Indicator.
Pilot's Left-hand auxiliary panel	Static Pressure Altimeter source Selector Valve.
Bombardier's panel	Airspeed Indicator Altimeter
Right outer-wing panel	Airspeed or Pitot-Static Head (located on bow forward of leading wing edge). Moisture traps in Pitot-Static lines.

Sperry Automatic Pilot Equipment (Spec. 94-27977)

*1	Control--Directional Gyro		Sperry 643915
*1	Gauge--Oil Pressure,	Type H-2	Spec. 94-27920
*1	Control--Bank & Climb Gyro		Sperry 643916
*1	Mount Assembly--Gyro Control Assembled with the following:		Sperry 643917
	1 Pulley--Elevator		Sperry 178849
	1 Pulley--Aileron		Sperry 178860
	1 Pulley--Rudder		Sperry 178847
*1	Filter--Air		Sperry 76516
*1	Valve--Speed Control		Sperry 644255

Outer Wing Instrument Equipment

*1	Airspeed Tube	Type D-1	Spec. 27876

INSPECTION AND MAINTENANCE

Engine Instrument Limitation Markings

Instrument	Operating Range (Green Arc)	Maximum & Minimum Permissible (Red Arc)	Cautionary Markings (Yellow Arc)
Cylinder Head Temperature	150° to 218° C	260° (Max. Take-off)	
Manifold Pressure	26.5 - 31.5 Hg.	44 Hg. (Max. Take-off)	

Tachometer	1550 - 2100 RPM	2600 (Max. Take-off)	
Fuel Press.	6 - 7 lbs./sq.in.		
Oil Press.	80 - 90 lbs./sq.in.	80 (Min. Safe) 90 (Max. Safe)	
Oil Temp.	47-5° - 85° C		40°C & Below 95°C & Above

Vacuum System Adjustment

The vacuum system adjustment is made as follows, with the ship resting on the ground:

Airplanes with Automatic Flight Control Equipment

Beginning with one pump at a time, regulate speed of the engine operating that pump to approximately 1000 RPM. The vacuum pressure will then be shown at the suction gauge on the pilot's instrument panel. Next, regulate the suction relief valve by turning the adjustment screw to give a vacuum pressure of 3.75 inches of mercury. Turn screw IN to increase pressure. Lock the adjustment. Now, increase the engine speed to the maximum RPM attainable on the ground and note the vacuum pressure. This indication must not exceed 4.25 inches of mercury. Repeat the same adjustment procedure for the other engine. After each vacuum pump has been regulated individually, check both vacuum pumps operating together at 1000 RPM (engine) and again at the maximum RPM attainable on the ground. The vacuum pressure should not exceed the limits of 3.75 inches of mercury minimum, and of 4.25 inches of mercury maximum. If either of these limits is exceeded, re-adjustments must be made.

If proper adjustment cannot be made, check the suction relief valve for cleanliness of screen, sticky valve, or loose adjustment.

Airplanes with Sperry Auto-Pilot

When making vacuum adjustment on airplanes equipped with Sperry Automatic Pilot equipment, the same general procedure outlined above is followed. However, because the Sperry-equipped airplanes have two vacuum systems, additional steps are necessary:

1. When adjusting for left-engine pumps, turn vacuum selector valve to position "L.H. Pump on Instruments - R.H. Pump on Auto-Pilot".

2. When adjusting for right-engine pump, turn selector valve to position "R.H. Pump on Instruments - L.H. Pump on Auto-Pilot".

3. Make all adjustments on the basis of readings taken on the instrument-panel suction gauge, not on the Auto-Pilot gauge.

4. In order to check the Auto-Pilot gauge to see that it is

working, the selector valve may be switched momentarily to the proper position. Operation limitations of the Auto-Pilot are from 4 to 5 inches of mercury; therefore, when the suction pressure is properly regulated the instrument gauge and Auto-Pilot gauge readings will not be the same.

The adjustment described above regulates the amount of vacuum required by the Turn Indicator and Flight Indicator at the pilot's station, and the camera at the camera station.

Bank and Turn Indicator Adjustment

The vacuum pressure for the Bank and Turn Indicator at the pilot's station is regulated by means of the needle valve (Fig.9) installed at the pilot's panel. Before this adjustment is made, the plug at the back of the Bank and Turn Indicator should be removed and a portable suction gauge connected. Regulate both engines to approximately 1000 RPM and adjust the needle valve to give an indication of 1.8 inches of mercury minimum. Then, regulate the engines to the maximum RPM attainable on the ground and note the indication, which should not exceed 2.05 inches of mercury. When this adjustment is made, disconnect the portable suction gauge and replace the plug.

The vacuum system is now in correct adjustment and ready for operation.

Vacuum Pump

The sealed ball-bearing contains a synthetic rubber seal disc which is held in position by a flat steel snap ring. The bearing is packed with high temperature grease by the manufacturer, and requires no further lubrication. However, it is advisable to repack the bearing with grease every 1000 hours.

Check the pump for security of mounting at 100-hour inspection. Remove the pump for overhaul as specified in T. O. 03-1-4.

Oil Separator

Remove the oil outlet fittings and screen, and clean in gasoline or some other suitable cleaning fluid at 100-hour inspection.

Oil collected in the de-icer system oil sump by the secondary oil separator must be drained after every 10 hours of engine operation. Remove the plug screw located under the fuselage just forward of the bomb bay. After draining, replace the plug and secure it with a lockwire.

The sump has a capacity of 3 pints.

Relief Valve

At regular engine overhaul periods, disassemble the valve and clean with gasoline. Inspect valve seats and spring tension, and replace parts that are badly worn.

Testing of Sperry Auto-Pilot Operation

No Gyro-pilot installation should be flown until it has passed a complete ground test. An installation which does not check satisfactorily on the ground cannot be expected to perform satisfactorily in the air. The ground test will catch any reversed connections not noticed during the installation inspection.

1. Start the engine and run it 600 to 700 RPM and note whether the oil pressure gauge and the vacuum gauge register. Within one or two minutes the oil pump should prime and indicate pressure. DO NOT ALLOW THE PUMP TO RUN DRY MORE THAN FIVE MINUTES. After it is certain that vacuum and oil pumps are working, run at 1000 RPM and set the vacuum regulator for 4-1/2 inches of mercury at the gauge, and set the oil pressure regulator to 100#. The speed valves should be closed while the oil pressure adjustment is being made.

2. Open speed valves at least four turns. Each numeral represents one turn of the knob.

3. Center the controls, align the follow-up indices, and then operate the controls by hand, moving them slowly from hard over to hard over, first one at a time, and then together a few times. Next hold each control at each extreme position for at least 30 seconds two or three times. This allows time for air in the servo to be pushed by oil flow through the system until it reaches the sump.

4. Shut down engines for a few moments to check for air in the servos, and replenish oil in the sump, some of which will have been passed on to the rest of the system. To check for air in the servos, turn the Gyro-pilot ON (engines not running.) The controls should act as though locked. Any "give" indicates that air in the servo is being compressed as force is applied to a control, and expanding as force is removed. Do not confuse stretching of cable with air in the servo. If any doubt exists, observe the indices on the control units for movement. Fill the sump 3/4 full before continuing with the ground test.

5. Start engines and run at 1000 RPM. Center all three controls, uncage gyros, leave speed valves open. Align the follow-up indices with the gyro indications, and turn the Gyro-pilot ON. All three controls should be in position. (If the airplane is not level, the Bank and Climb Gyro will move slowly toward the correct indication of the attitude of the airplane and cause the elevator and aileron controls to follow. The controls can be re-centered by rotating the hand control knobs).

6. Check for direction of control movement by turning each setting knob back and forth a small amount, making certain that each control moves in the direction marked at the knob.

7. Check for control speed balance as follows: Open all three speed control valves wide. Turn the Gyro-pilot OFF for a moment, and move the aileron control 15° over. Turn Gyro-pilot ON

quickly, and count the seconds required for the wheel or stick to come to neutral. Repeat for the opposite side. Time of return should not vary more than 25%. Follow same procedure for rudder and elevator. Up elevator may be considerably slower than down elevator, especially on large airplanes, due to the weight of the surface helping down movement and opposing up movement. CAUTION: Be sure that the tail of the airplane is not caused to rise when the elevator control is pushed all the way forward.

8. Check to be sure that the Gyro-pilot can be overpowered by hand controls with the Gyro-pilot ON.

If the above tests show proper operation, the equipment is ready for flight test. Should any faulty performance be found, correct it in accordance with Technical Order "Service Instructions" before proceeding with the Flight Test.

Instrument Maintenance

The screened passage for air at the back of each gyro instrument must be kept clean. If any other instrument trouble develops remove the instrument for check and repair at a qualified instrument repair shop.

Routine Check of Airspeed System

Two moisture traps, one for each of the air lines from the Pitot head, are located at the junction of the right wing leading edge and the fuselage. These moisture traps must be checked regularly to remove from the system any moisture, which would seriously interfere with the efficient operation of connected instruments.

Moisture and Heating Checks

The airspeed tube must be checked periodically to insure a free passage in the static slots and drain holes. The heating elements of this tube must be checked in conjunction with the electrical system.

Occasional checks of all fittings should be made to insure airtight connections.

Pressure Leak Test

The airspeed line pressure leak test should be made as follows:

Seal the airspeed tube pressure chamber drain holes, and connect the pressure opening of the airspeed tube to a water manometer. Apply a pressure of 10 inches of water slowly and then cut the source of pressure off from the system. During a period of 1 minute, the difference between the water levels in the manometer tube should not change by more than 1 inch. Remove pressure slowly.

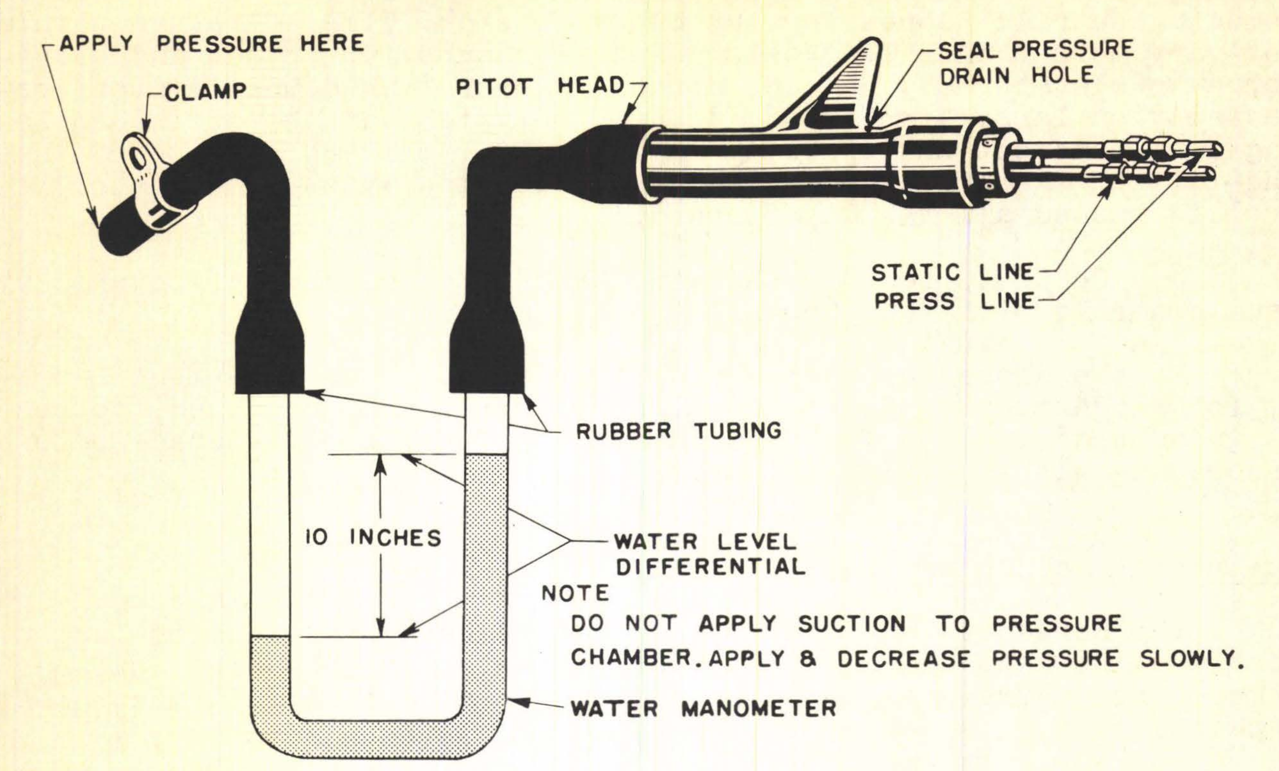


FIG. 24 AIRSPEED PRESSURE TEST

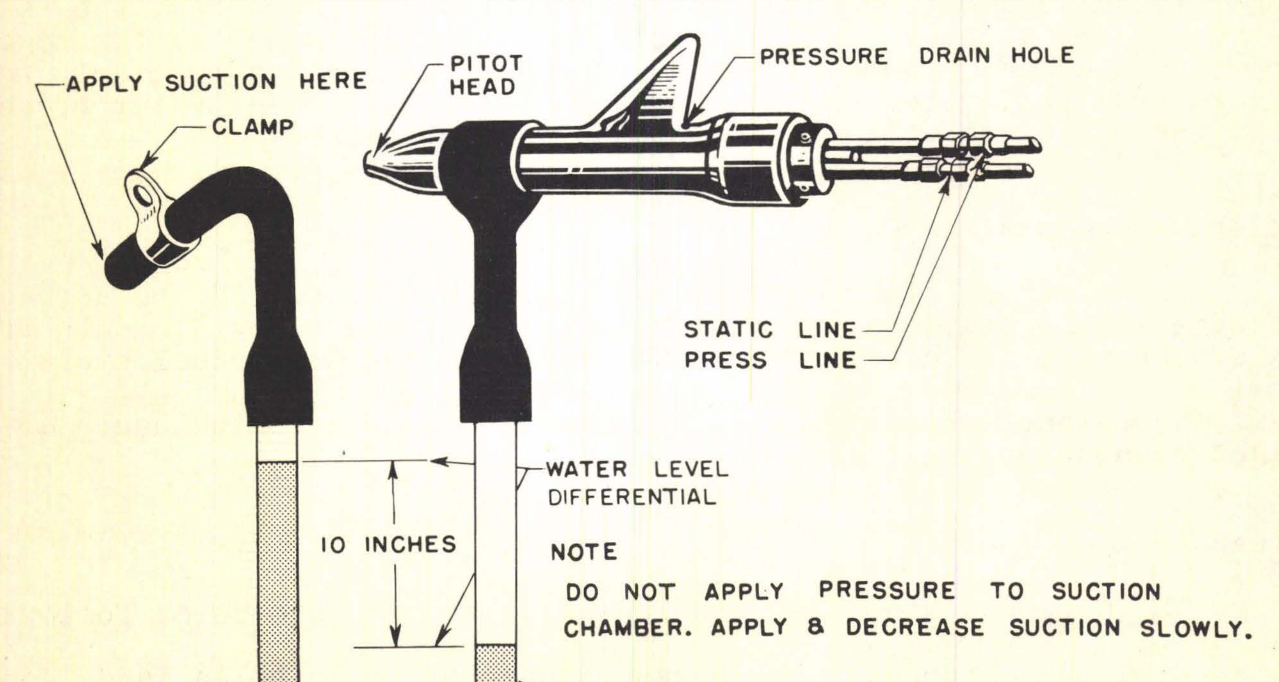


FIG. 25 AIRSPEED STATIC TEST

NOTE: DO NOT APPLY SUCTION TO PRESSURE LINES

Static Leak Test

The airspeed line static leak test,should be made as follows:

Seal the static pressure chamber drain holes and connect the static pressure openings of the airspeed tube to a water manometer. Slowly apply suction of 10 inches of water, then cut off the source of suction from the system. During a period of one minute the difference between the water levels in the manometer tube should not change by more than 1 inch.

NOTE: DO NOT APPLY PRESSURE TO STATIC PRESSURE LINES. REGULATE THE SLOW APPLICATION AND REMOVAL OF SUCTION BY MEANS OF THE RATE OF CLIMB INDICATOR WHICH SHOULD NOT SHOW A CHANGE OF MORE THAN 2000 FEET PER MINUTE.

Rate of Climb Indicator

Because the atmospheric pressure within the cockpit usually differs from that at the Pitot head,it is necessary that the instrument case be kept air-tight. Leaks are most likely to develop at the rim of the glass cover, or at the packing of the shaft of the knob with which the zero setting is made.

When setting the indicator to zero, tap the instrument to make sure that the pointer is properly set.

Drift Meter

The Drift Meter should be kept covered at all times when not in use in order to keep the instrument, especially the sights and scales, free from dust.

Landing Gear and Flap Indicator

If the indicator pointer moves continuously in one direction without hesitation when the landing gear or flaps are moved steadily in one direction, then the transmitter operation is correct. If the indicator hesitates or momentarily moves backward,there is poor contact in the transmitter. Remove and send to repair depot for overhaul.

Check the indicator for lag by turning the power switch on and noting the action of the pointers. They should snap into position without appearing to lag. When the power is off, the off markers should show fully.

If the pointers lag, the shafts and bearings probably need cleaning. This should be done by the repair depot.

Ground Swinging by Magnetic Bearing Base

The following method of swinging aircraft compasses, used by North American Aviation in compensating the B-25 compasses before delivery, is recommended by the Air Corps.

1. Place the airplane in level flying position on the base with the longitudinal axis parallel with the magnetic meridian; that is, parallel to the N-S line. If the compass does not indicate North zero (0)degrees adjust it to that indication by the following method: If the compensator is of the permanent magnet type, adjust the compensating screw marked N-S until the compass indicates North zero (0) degrees. Then, with the engines running and speeded up sufficiently so that the maximum charge is shown on the ammeter, note whether the compass heading still indicates North zero (0) degrees. If the compass head is affected by the electrical current flow, it will be necessary to make further magnetic corrections in order that the compass will indicate North zero (0) degrees under flight conditions.

2. Next, head the airplane East 90 degrees and repeat the above process, bearing in mind that in this position compensating magnets should be inserted in the fore and aft chamber (or the compensating screw marked "E-W" adjusted) to obtain the desired compass heading of East 90 degrees.

3. If, during the compensation of the compass on the North and East headings, there is no apparent change in the indications of the compass as a result of running the engines,there will be no further occasion to keep them running during the remaining period of compensation. However, with the engines stopped, the compass should be lightly tapped by hand before each reading is taken to make sure that the compass card has come to rest.

4. The airplane should next be headed South 180 degrees. If the compass does not indicate South, change the compensating magnets in the lateral chamber (or adjust the N-S compensating screw) to eliminate one-half of the error. By so doing, the error is divided between the North and South headings. The airplane should then be headed West 270 degrees. If the compass does not indicate West, adjust the E-W compensating screw to eliminate one-half of the error on this heading, thus dividing the error between the East and West headings. This procedure should result in a more even distribution of the compass error at all points.

5. The actual compensation is completed. Now swing the airplane on each successive 15 degree heading, starting at any convenient point, and record the compass readings in the "Radio Off" space provided on the compass correction card. Then with the radio receiver in the "ON" position, again swing the airplane on each successive 15 degree heading and record these compass readings in the "Radio On" space provided on the compass correction card.

6. All entries on the compass correction card, A. C. form No.

57, must be the actual indicated readings on all headings. After all entries have been properly made and the card dated and signed, place it in the holder provided for ready reference during flight.

Ground Swinging by Master Compass

To swing an airplane by using a master compass, the same procedure as outlined above should be followed, except that, instead of the magnetic bearing swinging base, any serviceable magnetic compass may be used as a master compass, providing the compensating magnets have been removed from it before it is so used. In no case should a compass having compensating magnets installed be used as a master compass. When swinging an airplane with a master compass, the compass should be attached to the wing as near the tip as possible by using a compass swinging frame (part number 0150996). These swinging frames have been supplied to service activities.

Daily Compass Checks

1. Check compasses daily for broken or loose cover glasses,or other visible defects.

2. Clean the compass cover glasses with a clean cloth.

3. Check compasses for discoloration of liquid and for evidence of bubbles.

Periodic Instrument Checks

1. Check instruments for too great movement and wavering of indicator pointer.

2. Check all instruments for broken or loose cover glasses, moisture in case, chipped paint on pointers or operating limit markings, or other visible defects.

Special attention should be given to cover-glasses that have been marked to indicate proper operating limits. In order to make any movement of the cover noticeable, a short line of dull white is painted on the glass and case at the bottom of the instrument. The alignment of the line on the case with that on the glass cover should be checked at each pre-flight inspection. In case a glass has become loose, it should be correctly placed and cemented to the case with Compound, sealing, aircraft instrument, Spec. 2-87.

3. Clean all instrument cover glasses with a clean, lint-free cloth.

4. See that clock in pilot's compartment is wound,running and correct according to Operation Office time.

5. Check temperature readings.

6. Check mounting of Free Air Temperature bulbs.

7. Check tightness of electrical and other connections.

MAINTENANCE PROBLEMS

Sperry Automatic Pilot

1. PROBLEM: EXCESSIVE VACUUM (OVER 5")

CAUSE	REMEDY
a. Air intake filter clogged	a. Replace with new filter element.
b. Shipping plug not removed from inlet end of air filter.	b. Remove plug.

2. PROBLEM: ALL THREE CONTROLS FAIL TO OPERATE IN EITHER DIRECTION.

CAUSE	REMEDY
a. Low or no vacuum (under 3" Hg); vacuum relief valve set too low.	a. Screw in adjusting screw. If increased vacuum does not result, valve is defective. If vacuum does not jump with hand held over air intake of valve, trouble is definitely elsewhere.
b. Pump failure.	b. Repair or replace pump.
c. Broken vacuum line.	c. Locate and repair.
d. Obstruction in vacuum line.	d. Locate and repair.
e. Engaging lever off.	e. Set to "ON".
f. Speed control valves closed.	f. Open speed control valves 2 to 4 turns.

3. PROBLEM: LOW OR NO OIL PRESSURE

CAUSE	REMEDY
a. Insufficient oil in system.	a. Fill sump to required level, (three-fourths full). After running engines 5 minutes with servo speed control up for oil fed into the system.
b. Pressure regulator out of adjustment.	b. Adjust with speed valves closed. Remove cap and loosen lock-nut. Screw in to raise pressure, out to lower presure.
c. Pump intake line or filter clogged.	c. Check line and filter.

4. PROBLEM: EXCESSIVE OIL PRESSURE

CAUSE	REMEDY
a. Oil pressure regulator set	a. Adjust with speed valves

4. a.	too high, or regulator stuck.	a.	closed. Remove cap and loosen locknut. Screw out to reduce pressure. Clean and readjust.

5. PROBLEM: FAILURE OF ONE OF THE CONTROLS

	CAUSE		REMEDY
a.	Speed valve closed.	a.	Open speed valve.
b.	Servo relief valve bypassing.	b.	Reset valve according to Reference 5 (a). (See next page).
c.	Balanced oil valve on.	c.	Remove rear cap and work valve back and forth by hand, with oil pressure on, Gyropilot off.
d.	Air relay stuck.	d.	Clean and replace.

6. PROBLEM: CONTROLS HUNTING

	CAUSE		REMEDY
a.	Air in oil system.	a.	Reference 6 (a). (Next page).
b.	Sticking oil valve.	b.	"Work valve manually" etc. Reference 6 (b). (Next page).
c.	Unbalance oil valve.	c.	Reset valve to neutral.
d.	Gyros caged.	d.	Uncage gyros.

7. PROBLEM: JERKY CONTROL

	CAUSE		REMEDY
a.	Sticky balanced oil valve.	a.	Free valve and clean if necessary. Valve will have to be rebalanced if removed for cleaning.

8. PROBLEM: CONTROL IN ONE DIRECTION ONLY

	CAUSE		REMEDY
a.	Balanced oil valve restricted by dirt.	a.	Operate manually to check. Free and clean valve if dirt cause of trouble.
b.	Follow-up or piping reversed.	b.	Connect according to control diagram.
c.	Air leak at air pick-off grommet between control unit and mounting bracket.	c.	Install new grommet and check.

Reference 5 (a)

The conditions which govern the settings of the servo relief

valves are: (1) they should open readily in either direction without excessive manual effort being applied to over-power the gyro pilot, and (2) they should not open during normal flight conditions in smooth or rough air. The best settings to meet these conditions will usually be found between 75% and 100% of Gyro-pilot operating pressure. To set the relief valves, tee in two oil pressure gauges of 300 pounds range, one in each line, to the servo cylinder at the point where the lines from the balanced oil valves are normally attached.

Reference 6 (a)

Move controls back and forth manually with engine running and Gyro-pilot OFF. Hold each control at one and then the other extreme position for one minute. This permits continuous flow of oil down one servo line, through the by-pass, and into the other line. Thus any air is carried back to the sump via the exhaust line. The follow-up indices should be set neutral at the start, with the controls at neutral.

Reference 6 (b)

Work valve manually until free, then hold at each extreme position for about 2 minutes, to allow any dirt to be carried back to the sump. This should be done with Gyro-pilot engaging lever in OFF position.

Suction Gauge

1. PROBLEM: EXCESSIVE WAVERING OF POINTER

POSSIBLE CAUSE	REMEDY
a. Rough relief valve seat.	a. Adjust or replace relief valve.

Flight Indicator

1. PROBLEM: SLUGGISH OPERATION

POSSIBLE CAUSE	REMEDY
a. Insufficient vacuum.	a. Check and adjust vacuum. Clean screens, Replace instruments.

2. PROBLEM: FAILURE OF HORIZON BAR TO SETTLE

POSSIBLE CAUSE	REMEDY
a. Excessive vibration.	a. Check mounting panel, shock absorbers. Replace,if necessary.

2. b. Fouled vanes in rotor. Gimbals out of balance Worn pivots or bearings.	b. Replace instrument.
c. Insufficient suction.	c. Check and adjust vacuum.

3. PROBLEM: HORIZON BAR OSCILLATES OR SHIMMIES CONTINUOUSLY

POSSIBLE CAUSE	REMEDY
a. Excessive vibration.	a. Check mounting panel shock absorbers. Replace if defective.
b. Vacuum too high.	b. Check and adjust vacuum.
c. Worn rotor pivots or bearings.	c. Replace instrument.

4. PROBLEM: HORIZON BAR DOES NOT AGREE WITH FLIGHT ATTITUDE

POSSIBLE CAUSE	REMEDY
a. Instrument out of alignment on panel.	a. Correct alignment.

5. PROBLEM: HORIZON BAR AND BANKING INDICATOR NOT PERPENDICULAR TO EACH OTHER.

POSSIBLE CAUSE	REMEDY
a. Mechanism out of alignment.	a. Replace instrument.

Turn Indicator

1. PROBLEM: EXCESSIVE DRIFT OF CARD

POSSIBLE CAUSE	REMEDY
a. Improper suction; excessive vibration.	a. Check and adjust suction; Check mounting panel shock absorbers; replace if defective. If trouble still persists, replace instrument.

2. PROBLEM: CAGING MECHANISM WORKS HARD

POSSIBLE CAUSE	REMEDY
a. Lack of lubrication or corrosion around shaft.	a. Lubricate external part of shaft with instrument oil.

3. PROBLEM: INSTRUMENT LACKS SENSITIVITY

POSSIBLE CAUSE	REMEDY
a. Insufficient speed of gyro rotor, dirty screens.	a. Clean screens and check suction.

Bank and Turn Indicator

1. PROBLEM: POINTER DOES NOT SET ON ZERO; OTHERWISE SMOOTH POINTER OPERATION

POSSIBLE CAUSE	REMEDY
a. Gimbal and rotor assembly out of balance.	a. Replace instrument.
b. Pointer incorrectly set on its staff.	b. Replace instrument.
c. Sensitivity spring adjustment. Pulls pointer off zero.	c. Replace instrument.

2. PROBLEM: INCORRECT SENSITIVITY

POSSIBLE CAUSE	REMEDY
a. Vacuum too high or too low.	a. Examine tubing, connections, control valve etc. for leaks or stoppage.
b. Air inlet cap or air inlet screen clogged.	b. Remove cap or screen, clean and replace.
c. Misadjustment of sensitivity spring.	c. Have adjustment made by qualified repair man.

3. PROBLEM: VIBRATING POINTER

POSSIBLE CAUSE	REMEDY
a. Excessive vibration	a. Check instrument board for excessive vibration and correct, if found necessary.
b. Damping screw misadjustment.	b. Adjust damping screw on left side of instrument until proper operation is obtained.
c. Lack of oil.	c. Lubricate instrument through plug on right side.

4. PROBLEM: POINTER SLUGGISH IN RETURNING TO ZERO OR DOES NOT RETURN TO ZERO; ERRATIC POINTER OPERATION

POSSIBLE CAUSE	REMEDY
a. Oil or dirt between damping piston.	a. Replace instrument.
b. Excessive clearance between rotor and rotor pivots.	b. Replace instrument.

Airspeed Indicator Assembly

1. PROBLEM: POINTER FAILS TO RESPOND

1.

POSSIBLE CAUSE	REMEDY
a. Dynamic (Pitot) pressure connections (P) not connected properly to dynamic pressure line from Pitot-static tube.	a. Check tubing and connections for leaks.
b. Dynamic or static pressure line from Pitot-static tube clogged.	b. Disconnect dynamic and static pressure lines from all instruments. Open pet-cock or drain at lowest point of each tube line. Blow through tubing to remove obstruction.

2. PROBLEM: POINTER INDICATES INCORRECTLY

POSSIBLE CAUSE	REMEDY
a. Leak in tubing from Pitot-static or in connections.	a. Check lines to Pitot-static tube for leaks.
b. Leak in indicator case.	b. Replace with serviceable instruments.

3. PROBLEM: POINTER DOES NOT SET ON ZERO WHEN AIRPLANE IS ON THE GROUND

POSSIBLE CAUSE	REMEDY
a. Defective indicator mechanism.	a. Replace with serviceable instrument.

4. PROBLEM: POINTER VIBRATES

POSSIBLE CAUSE	REMEDY
a. Excessive vibration of instrument board.	a. Check instrument board and if excessive vibration is apparent,replace worn or deteriorated Lord mounting units.
b. Excessive vibration of tubing.	b. Install length of flexible tubing (approx. 10") between indicator and each line.

5. PROBLEM: POINTER OSCILLATION

POSSIBLE CAUSE	REMEDY
a. Leak in tubing from Pitot-static or in connections.	a. Disconnect lines to airspeed indicator. Check lines to Pitot-static tube for leaks.
b. Leak in indicator case.	b. Replace with serviceable instruments.

Rate of Climb Indicator

1. PROBLEM: POINTER DOES NOT SET ON ZERO

POSSIBLE CAUSE	REMEDY
a. Aging of diaphragm.	a. Reset pointer to zero by means of setting knob. Tap instrument while resetting.

2. PROBLEM: POINTER FAILS TO RESPOND

POSSIBLE CAUSE	REMEDY
a. Obstruction in static line.	a. Disconnect all instruments connected to static line. Open drain plug in static line and blow line clear.
b. Defective mechanism.	b. Replace instrument.

3. PROBLEM: POINTER INDICATES INACCURATELY

POSSIBLE CAUSE	REMEDY
a. Leaks in static line.	a. Disconnect all instruments connected to static line. Check line for leaks. Check individual instruments for leaks. Reconnect instruments to static line and test installation for leaks.
b. Defective mechanism.	b. Replace instrument.

4. PROBLEM: POINTER OSCILLATES

POSSIBLE CAUSE	REMEDY
a. Leaks in static line.	a. Disconnect all instruments connected to static line. Check individual instruments for leaks. Reconnect instruments to static line and test installation for leaks.
b. Restriction plug not installed.	b. Install restriction plug. T. O. 05-20-11.
c. Defective mechanism.	c. Replace instrument.

Altimeter

1. PROBLEM: HIGH READING

POSSIBLE CAUSE	REMEDY
a. Improper venting.	a. Eliminate leak in static pressure system and check alignment of airspeed tube.

2. PROBLEM: SETTING KNOB TURNS HARD

POSSIBLE CAUSE	REMEDY
a. Wrong lubrication or lack of lubrication.	a. Replace instrument.

3. PROBLEM: INNER REFERENCE MARKER FAILS TO MOVE WHEN SETTING KNOB IS ROTATED

POSSIBLE CAUSE	REMEDY
a. Out of engagement.	a. Replace instrument.

4. PROBLEM: BAROMETRIC SCALE AND REFERENCE MARKERS OUT OF SYNCHRONISM

POSSIBLE CAUSE	REMEDY
a. Slippage in mating parts.	a. Replace instrument.

5. PROBLEM: BAROMETRIC SCALE AND REFERENCE MARKERS OUT OF SYNCHRONISM WITH POINTERS

POSSIBLE CAUSE	REMEDY
a. Drift in the mechanism, or careless maintenance.	a. Reset pointers.

Autosyn System

1. PROBLEM: INDICATION 180° IN ERROR

POSSIBLE CAUSE	REMEDY
a. The "A" terminals of transmitter and indicator not on same side of line (system short circuited).	a. Locate and correct improper connections.

2. PROBLEM: POINTER TAKES EITHER CORRECT POSITION OR IS 180° IN ERROR

POSSIBLE CAUSE	REMEDY
a. Power fails to reach indicator rotor "A" or "G" circuit open.	a. Determine if power reaches terminals. Check fuses and indicator.

3. PROBLEM: INDICATOR POINTER HAS ONLY SMALL ERRATIC MOVEMENT

3.

POSSIBLE CAUSE	REMEDY
a. Power fails to reach transmitter rotor ("A" or "G" circuit open).	a. Determine if your power reaches terminals. Check fuses and transmitter brushes.

4. PROBLEM: INDICATOR MOVES ONLY THROUGH 120° IN ERROR

POSSIBLE CAUSE	REMEDY
a. Open circuit to terminals "1", "2" or "3".	a. Check continuity of wiring.

5. PROBLEM: INDICATOR ZERO POSITION APPROXIMATELY 120° IN ERROR

POSSIBLE CAUSE	REMEDY
a. Connections to terminals "1", "2" or "3" interchanged.	a. Connect together like-numbered terminals on transmitter and indicator.

6. PROBLEM: INDICATOR TURNS IN WRONG DIRECTION

POSSIBLE CAUSE	REMEDY
a. Connections to terminals "1", "2" or "3" interchanged.	a. Connect together like-numbered terminals on transmitter and indicator.

7. PROBLEM: LOW READING ON INDICATOR EITHER PERMANENT OR INTERMITTENT

POSSIBLE CAUSE	REMEDY
a. Poor connections at indicator or generator terminals.	a. Clean and tighten terminals.
b. Zero-corrector screw off adjustment on indicator.	b. Disconnect lead and reset pointer to zero.
c. Generator brushes worn.	c. Replace brushes, clean commutator.
d. Defective indicator pivots.	d. Replace indicator and generator.

8. PROBLEM: HIGH READING ON INDICATOR EITHER PERMANENT OR INTERMITTENT

POSSIBLE CAUSE	REMEDY
a. Zero-corrector screw off adjustment on indicator.	a. Disconnect lead and reset pointer to zero.
b. Indicator resistance off adjustment.	b. Replace indicator and generator.

Fuel Pressure Gauge

1. PROBLEM: EXCESSIVE ERROR AT ZERO

POSSIBLE CAUSE	REMEDY
a. Pointer loose on shaft.	a. Have pointer reset and calibrated by qualified instrument repair man.
b. Excessive pressure	b. Have pointer reset and calibrated by qualified instrument repair man.

2. PROBLEM: EXCESSIVE SCALE ERROR

POSSIBLE CAUSE	REMEDY
a. Excessive pressure.	a. Have adjustment made by qualified repair man.
b. Excessive vibration.	b. Have adjustment made by qualified repair man.

3. PROBLEM: EXCESSIVE POINTER OSCILLATION

POSSIBLE CAUSE	REMEDY
a. Improper damping.	a. Disconnect line and drain; reconnect making sure there are no leaks. If trouble persists, work on relief valve.
b. Rough relief valve.	b. Repair.

Oil Pressure Gauge

1. PROBLEM: EXCESSIVE POINTER OSCILLATION

POSSIBLE CAUSE	REMEDY
a. Improper damping or rough relief valve.	a. Disconnect line and drain. Reconnect making sure there are no leaks. If trouble still persists, clean and adjust relief valve.

2. PROBLEM: SLUGGISH OPERATION OF POINTER

POSSIBLE CAUSE	REMEDY
a. Low temperature of fluid in line.	a. Drain line and refill.

Manifold Pressure Gauge Assembly

1. PROBLEM: EXCESSIVE ERROR AT EXISTING BAROMETRIC PRESSURE

POSSIBLE CAUSE	REMEDY
a. Pointer shifted.	a. Reset pointer to "zero" position (existing manifold pressure).

2. PROBLEM: EXCESSIVE ERROR WHEN ENGINE IS RUNNING

POSSIBLE CAUSE	REMEDY
a. Line leak.	a. Tighten line connections; be sure drain cock is closed when test for leak is made.

3. PROBLEM: SLUGGISH OR JERKY POINTER MOVEMENT

POSSIBLE CAUSE	REMEDY
a. Improper damping adjustment.	a. Adjust damping screws.

Oil Temperature Gauges

1. PROBLEM: EXCESSIVE ERROR AT MECHANICAL ZERO

POSSIBLE CAUSE	REMEDY
a. Improper adjustment.	a. Have adjustment made by qualified person.

2. PROBLEM: NO READING WITH PANEL SWITCH "ON"

POSSIBLE CAUSE	REMEDY
a. Panel switch defective.	a. Replace or repair switch.
b. Poor connections at switch terminals.	b. Clean and tighten connections.
c. Break in battery or ground leads.	c. Repair or replace leads.
d. Open or short circuit in indicator.	d. Replace indicator.

3. PROBLEM: READINGS OFF SCALE AT LOW TEMPERATURE END

POSSIBLE CAUSE	REMEDY
a. Short circuit in leads resistance bulb.	a. Repair or replace lead.
b. Short circuit in resistance bulb.	b. Replace resistance bulb.

4. PROBLEM: READINGS OFF SCALE AT HIGH TEMPERATURE END

POSSIBLE CAUSE	REMEDY
a. Break in leads to resistance bulb.	a. Repair or replace lead.
b. Open circuit in resistance bulb.	b. Replace bulb.
c. Open or short circuit in indicator.	c. Replace indicator.

5. PROBLEM: LOW OR HIGH READING EITHER PERMANENT OR INTERMITTENT

POSSIBLE CAUSE	REMEDY
a. Battery low.	a. Charge battery.
b. Poor connection in leads to battery.	b. Repair
c. Poor connection in leads to switch.	c. Repair
d. Defective panel switch	d. Replace or repair switch.
e. Zero corrector off adjustment.	e. Have adjustment made by qualified person.
f. Defective indicator.	f. Replace.
g. Defective resistance bulb.	g. Replace.

Tachometer Assembly

1. PROBLEM: EXCESSIVE ERROR AT ZERO

POSSIBLE CAUSE	REMEDY
a. Vibration.	a. Have adjustment made by qualified person.

2. PROBLEM: EXCESSIVE SCALE ERROR

POSSIBLE CAUSE	REMEDY
a. Weak magnets in generator.	a. Replace both generator and indicator.

3. PROBLEM: INSTRUMENTS OUT OF SYNCHRONISM

POSSIBLE CAUSE	REMEDY
a. Generators putting out different voltage at same RPM.	a. Remove generators and synchronize on bench test tachometer stand.

4. PROBLEM: POINTER MOVES BACKWARDS

POSSIBLE CAUSE	REMEDY
a. Reversed polarity.	a. Change leads at terminals on generator.

5. PROBLEM: INDICATION ONLY ONE-HALF ACTUAL SPEED

POSSIBLE CAUSE	REMEDY
a. Leads connected to wrong terminal on indicator.	a. Use terminal No. 1 for one indicator, and No. 2 for two indicators.

6. PROBLEM: NO READING ON INDICATION EITHER PERMANENT OR INTERMITTENT

POSSIBLE CAUSE	REMEDY
a. Break or short circuit in leads.	a. Repair.
b. Poor connections at indicator or generator terminals.	b. Clean and tighten terminals.
c. Break inside indicator or generator circuits.	c. Replace indicator and generator.

Thermocouple Indicator Assembly

1. PROBLEM: NO READING, EITHER PERMANENT OR INTERMITTENT

POSSIBLE CAUSE	REMEDY
a. Break in leads.	a. Replace leads.
b. Break in indicator switch.	b. Replace instrument or switch.

2. PROBLEM: LOW READING, EITHER PERMANENT OR INTERMITTENT

POSSIBLE CAUSE	REMEDY
a. High resistance caused by loose connections or poor contacts at terminals.	a. Clean terminals and tighten connection
b. Short circuit in leads.	b. Replace or repair leads.
c. Short circuit in thermocouple.	c. Repair.
d. Zero corrector shifted.	d. Reset.

3. PROBLEM: EXCESSIVE SCALE ERROR

POSSIBLE CAUSE	REMEDY
a. Broken lead or loose connections.	a. Check lead. Replace if broken.

Fuel Level Gauge

1. PROBLEM: EXCESSIVE ERROR AT "EMPTY" OR "FULL" POSITIONS

POSSIBLE CAUSE	REMEDY
a. Improper range adjustment.	a. Make correction with stroke adjustment.

2. PROBLEM: BROKEN WIRE IN WINDINGS OF TANK RHEOSTAT

POSSIBLE CAUSE	REMEDY
a. Excessive friction and wear.	a. Replace rheostat assembly.

3. PROBLEM: POOR CONTACT BETWEEN SHOES AND WINDINGS IN TANK UNITS

POSSIBLE CAUSE	REMEDY
a. Dirt or corrosion.	a. Dismantle and clean with crocus cloth.

4. PROBLEM: EXCESSIVE SCALE ERROR

POSSIBLE CAUSE	REMEDY
a. Unbalanced resistance.	a. Make correction on rheostat in stroke adjustment box.

5. PROBLEM: EXCESSIVE RANGE ERROR

POSSIBLE CAUSE	REMEDY
a. Potentiometer out of adjustment (tank end).	a. Make adjustment in tank unit.

Hydraulic Pressure Gauge

1. PROBLEM: EXCESSIVE ERROR AT ZERO

POSSIBLE CAUSE	REMEDY
a. Pointer loose on shaft.	a. Have pointer reset or gauge calibrated by qualified person.
b. Excessive overpressure.	b. Have pointer reset or gauge calibrated by qualified person.
c. Seasoning of Bourdon tube.	c. Have pointer reset or gauge calibrated by qualified person.

2. PROBLEM: EXCESSIVE POINTER OSCILLATION

POSSIBLE CAUSE	REMEDY
a. Improper damping.	a. Disconnect line to instrument and drain. Reconnect line and make sure there are no leaks.

3. PROBLEM: EXCESSIVE SCALE ERROR

3. POSSIBLE CAUSE — REMEDY

POSSIBLE CAUSE	REMEDY
a. Improper calibration	a. Adjust and calibrate gauge.

Drift Meter

1. PROBLEM: RETICLE FAILS TO REMAIN UPRIGHT WITH GYRO UNCAGED

POSSIBLE CAUSE	REMEDY
a. No vacuum.	a. Examine source of vacuum supply and tubing for leaks, stoppage or pump failure.
b. Air filter dirty reducing air flow.	b. Examine filter and replace if necessary.
c. Leaks in instrument case.	c. See that all screws in gyro housing are tight.
d. Dirty or tight gimbal bearings.	d. Clean gimbal bearings.

2. PROBLEM: RETICLE DOES NOT SETTLE VERTICAL

POSSIBLE CAUSE	REMEDY
a. Excessive vibration	a. Check vibration of instrument.
b. Low vacuum.	b. Check vacuum at instrument.
c. Air filter dirty reducing Air flow.	c. Examine filter and replace if necessary.
d. Friction in gyro gimbal pivots.	d. Replace instrument.

3. PROBLEM: RETICLE OSCILLATES

POSSIBLE CAUSE	REMEDY
a. Excessive vibration.	a. Check vibration of instrument.
b. Worn rotor bearings.	b. Replace instrument.

Magnetic Compasses

1. PROBLEM: EXCESSIVE CARD ERROR

POSSIBLE CAUSE	REMEDY
a. Compass not properly compensated.	a. Compensate instrument.
b. External magnetic interference.	b. Locate magnetic interference and eliminate if possible.

2. PROBLEM: EXCESSIVE CARD OSCILLATION

POSSIBLE CAUSE	REMEDY
a. Insufficient liquid.	a. Remove instrument and fill liquid.

2. b.	Excessive vibration of instrument mount.	b.	Remove excessive vibration of instrument mount.

3. PROBLEM: CARD ELEMENT NOT LEVEL

	POSSIBLE CAUSE		REMEDY
a.	Leaking float chamber.	a.	Replace instrument.
b.	Card magnets detached from card.	b.	Replace instrument.

4. PROBLEM: CARD SLUGGISH

	POSSIBLE CAUSE		REMEDY
a.	Weak card magnets.	a.	Replace instrument.
b.	Excessive pivot friction or broken jewel.	b.	Replace instrument.
c.	Instrument heavily compensated.	c.	Remove excessive compensation.

5. PROBLEM: LIQUID LEAKAGE

	POSSIBLE CAUSE		REMEDY
a.	Loose bezel screws.	a.	Tighten bezel screws uniformly.
b.	Broken cover glass or case.	b.	Replace instrument.
c.	Defective sealing gaskets.	c.	Replace instrument.

INSTRUMENT REVIEW QUESTIONS

1. Name the four general groups of Instrument Equipment, installed on B-25 airplanes.

2. In what manner does the vacuum system used with Sperry Auto-Pilot Equipment differ from that used with A.F.C.E.?

3. What settings are provided on the Sperry Auto-Pilot vacuum system Selector Valve? What Selector Valve setting is used when testing vacuum pressure of the left-engine vacuum pump?

4. What vacuum pressure is required for operation of the Flight Instruments?

5. Trace the suction flow through the vacuum system from pump to instruments, locating and explaining the use of each piece of vacuum equipment in the line.

6. Describe the steps taken in adjusting the vacuum pressure for the Flight Indicator and Turn Indicator. For the Bank and Turn Indicator.

7. Explain the operation of the Sperry Automatic Pilot.

8. Describe the steps taken in testing the operation of the Sperry Auto-Pilot.

9. The pilot uses the following Flight Instruments to aid him in "blind flying": Flight Indicator, Turn Indicator, Turn and Bank Indicator. Describe the uses of each.

10. When should the Flight Indicator gyro be "caged"? Why is this necessary?

11. Considering the operation of the three Flight Instruments, why are they connected together?

12. Why is it necessary to have several flight instruments which serve nearly the same purposes?

13. What instruments are classified as airspeed and Pitot-Static Instruments?

14. Explain how pressure and static air are obtained at the Pitot head.

15. Explain the principle of operation of (a) Airspeed Indicator; (b) Rate of Climb Indicator; (c) Altimeter.

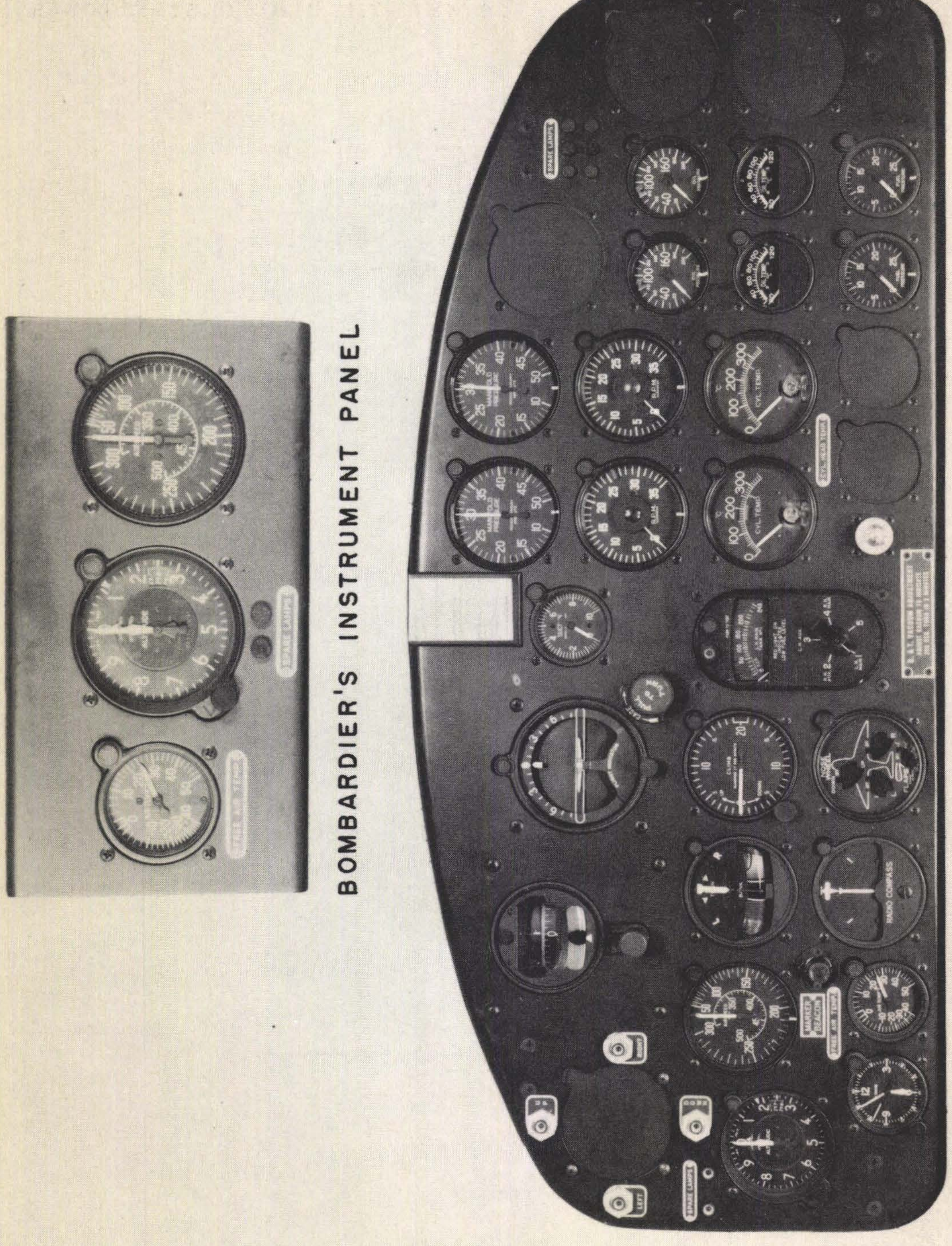
16. Name the engine instruments of the Autosyn type used on the B-25C. On the B-25D. Where and how are the transmitters mounted?

17. Can the connections of the cylinder head temperature thermocouple to the indicator be interchanged? Explain.

18. Describe the various positions shown on the Landing Gear and Flap Position Indicator. Tell what each indicates.

19. What is the principle of operation of the fuel-level indication system? Locate the tank end units and indicating instruments.

20. List the instruments found at the various stations: Pilot's, Bombardier's, and navigator's.



BOMBARDIER'S INSTRUMENT PANEL

PILOT'S INSTRUMENT PANEL

FIG. 26

ADDENDUM

As regards instruments, the B-25 airplanes have always been completely equipped. However, there have been changes in types of instruments and equipment used. The following information relates only to equipment which has been superceded and is not discussed in the body of the lecture.

EQUIPMENT LIST
(B-25, B-25A and B-25B Airplanes Only.)

1. Pilot's Station Instrument Equipment

1	Turn Indicator	Type B-3	Spec. 27801
1	Flight Indicator or	Type C-5	Spec. 27802
1	Flight Indicator	Type C-7	Spec. 27962
1	Altimeter or	Type C-11	Spec. 27857
1	Altimeter	Type C-13	Spec. 27958
1	Airspeed Indicator	Type D-4	Spec. 27805
1	Bank and Turn Indicator	Type A-5	Spec. 94-27803
1	Rate of Climb or	Type A-6	Spec. 27782
1	Rate of Climb	Type A-7	Spec. 27956
1	Clock or	Type A-9	Spec. 27879
1	Clock	Type A-11	Spec. 27970
1	Suction Gauge or	Type F-2	Spec. 9427813
1	Suction Gauge	Type F-3	Spec. 27923
1	Compass	Type B-17	Spec. 27815
1	Free Air Temp.	Type C-6	Spec. 27822
1	Hydraulic Pressure Gauge	Type E-3	U. S. Ga.Co. AW-1-7/8-17E
1	Brake Pressure Gauge or	Type E-3	Spec. 27812
1	Brake Pressure Gauge	Type E-4	Spec. 27922
1	Pilot Director		Spec. C-24580
1	Radio Compass	Type I-65-C	H-39B6029
1	Position Indicator Landing Gear and Flaps General Electric 8 DJ-4PWE		
1	Fuel Level Gauge (B-25Airplane) Liquidometer 49AW-2		Spec. 27737-D
1	Fuel Level Gauge (B-25A and B-25B Airplane) 49AW-3		Spec. 27737-D
2	Manifold Pressure Gauge or	Type D-2	Spec. 27811-A
2	Manifold Pressure Gauge	Type D-9	Spec. 27937
2	Tachometer (12 volts)	Type E-4	Spec. 27817
2	Thermocouple Indicator or	Type B-7	Spec. 27821
2	Thermocouple Indicator	Type B-9	Spec. 27928
2	Fuel Pressure Gauge	Type C-10	Spec. 27856
1	Needle Valve	Parker	4561-1-1/8-D
2	Oil Pressure Gauge or	Type B-5	Spec. 27809
2	Oil Pressure Gauge	Type B-8	Spec. 94-27917
2	Oil Temperature Gauge	Type A-16	Spec. 27860

2. Bombardier's Station Instrument Equipment

1	Airspeed Indicator	Type D-4	Spec. 27805
1	Altimeter or	Type C-11	Spec. 27857
1	Altimeter	Type C-13	Spec. 27958
1	Compass	Type B-16	Spec. 27807
1	Free Air Temp. Indicator	Type C-6	Spec. 27822

3. Navigator's Station Instrument Equipment

1	Compass	Type D-12	Spec. 27825
1	Drift Meter	Type B-3 (58 Overall Dim.)	Spec. 27796

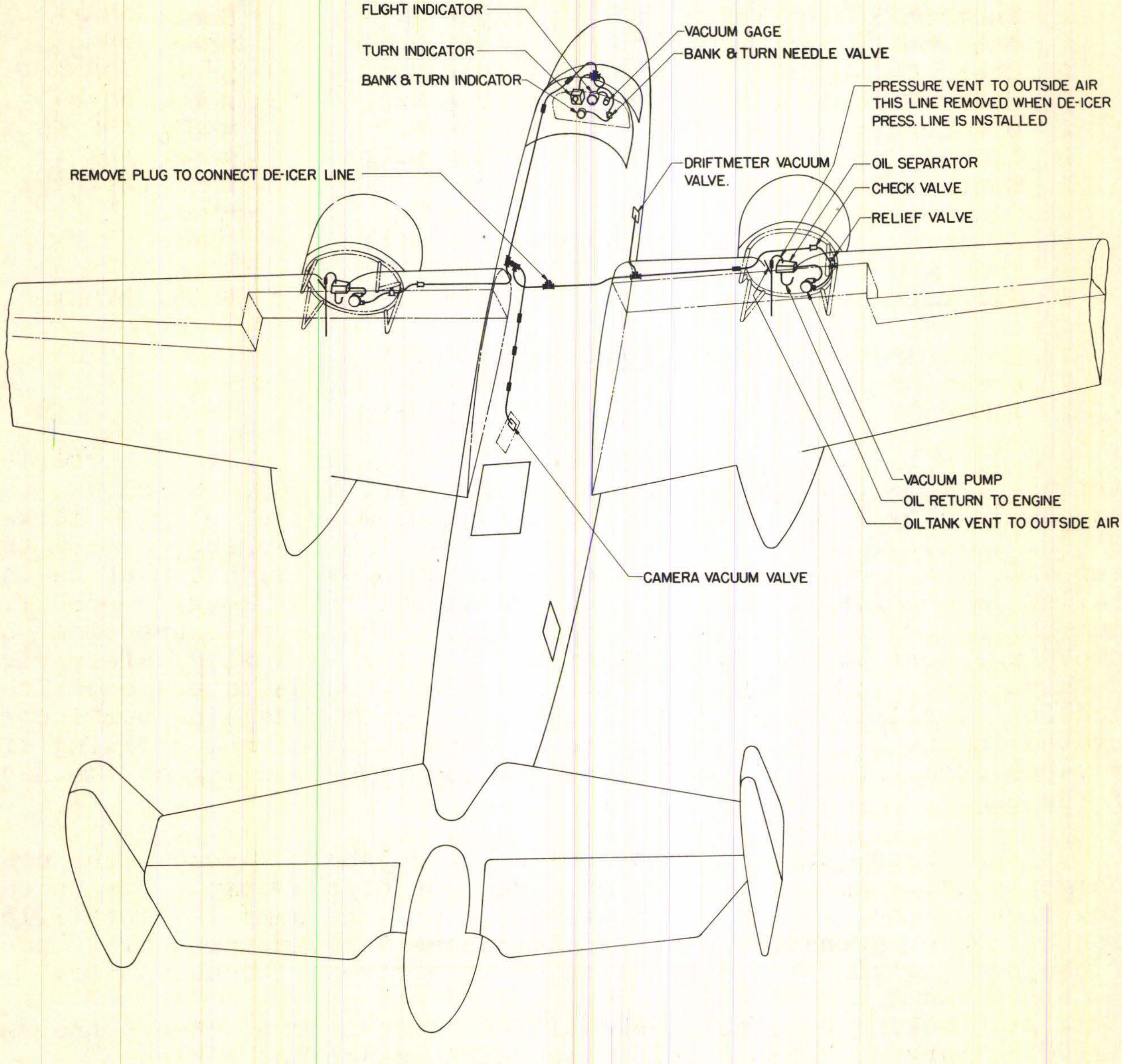


FIG. 27 VACUUM SYSTEM INSTALLATION (B-25, B-25A and B-25B)

1	De-Icer Pressure Gauge	Type G-1	Spec. 27841

4. Camera Station Instrument Equipment

1	Vacuum Shut-Off Valve	Parker	8PVGG-D

5. Engine Compartment Instrument Equipment

2	Vacuum Pump or	Type B-7	Spec. 278367-A
2	Vacuum Pump	Type B-12	Spec. 28391
2	Suction Relief Valve or	Type B-7	Spec. 278367-A
2	Suction Relief Valve	Type B-12	Spec. 28391
2	Check Valve or	Type B-7	Spec. 278367-A
2	Check Valve (De-Icer System)	Type B-12	Spec. 28391
2	Oil Separator or	Type B-7	Spec. 278367-A
2	Oil Separator	Type B-12	Spec. 28391
2	Check Valve		Eclipse 3032A-3

6. Outer Wing Instrument Equipment

1	Airspeed Tube	Type C-7	Spec. 27884

INSTRUMENT AND MAINTENANCE

7. Vacuum Instruments Operation

A Type B-7 Vacuum Pump was installed on the early B-25 series airplanes. This pump has a special plug marked "SUCT." to block the passage leading to the suction side of the pump; the plug marked "PRESS.", allows a restricted air flow from the discharge side of the pump into the neck. These plugs are interchangeable, but must be installed in accordance with the pump rotation; that is, with "SUCT." plug on suction side of pump, and "PRESS." plug on pressure side of pump.Plugs must be carefully tightened and fastened with safety wire. The high speed (3900 RPM) of the pump rotor necessitates good lubrication at all times to prevent seizure.The by-pass line was incorporated in the B-7 vacuum pumps to prevent suction from drawing oil or vapor from the engine crankcase through the coupling at the neck of the pump.

It has been found that the engine drive shaft in some cases discharges a large amount of oil into the neck of the pump. Due to the slow flow in the gravity drain, the neck of the pump is kept filled with oil under pressure, and the oil passes through the outlet port of the pump, giving the appearance of excessive oil consumption.

When making routine checks of the vacuum pump, remove the special plug marked "PRESS.", clean the air passage and replace.

8. Vacuum Pump Installation

The Type B-12 vacuum pump already described was installed on later models of the B-25, B-25A and B-25B airplanes. A number of the early B-12 vacuum pumps incorporated the old B-7 pump cases only and have two unmarked plugs. However, these two plugs do not require in-

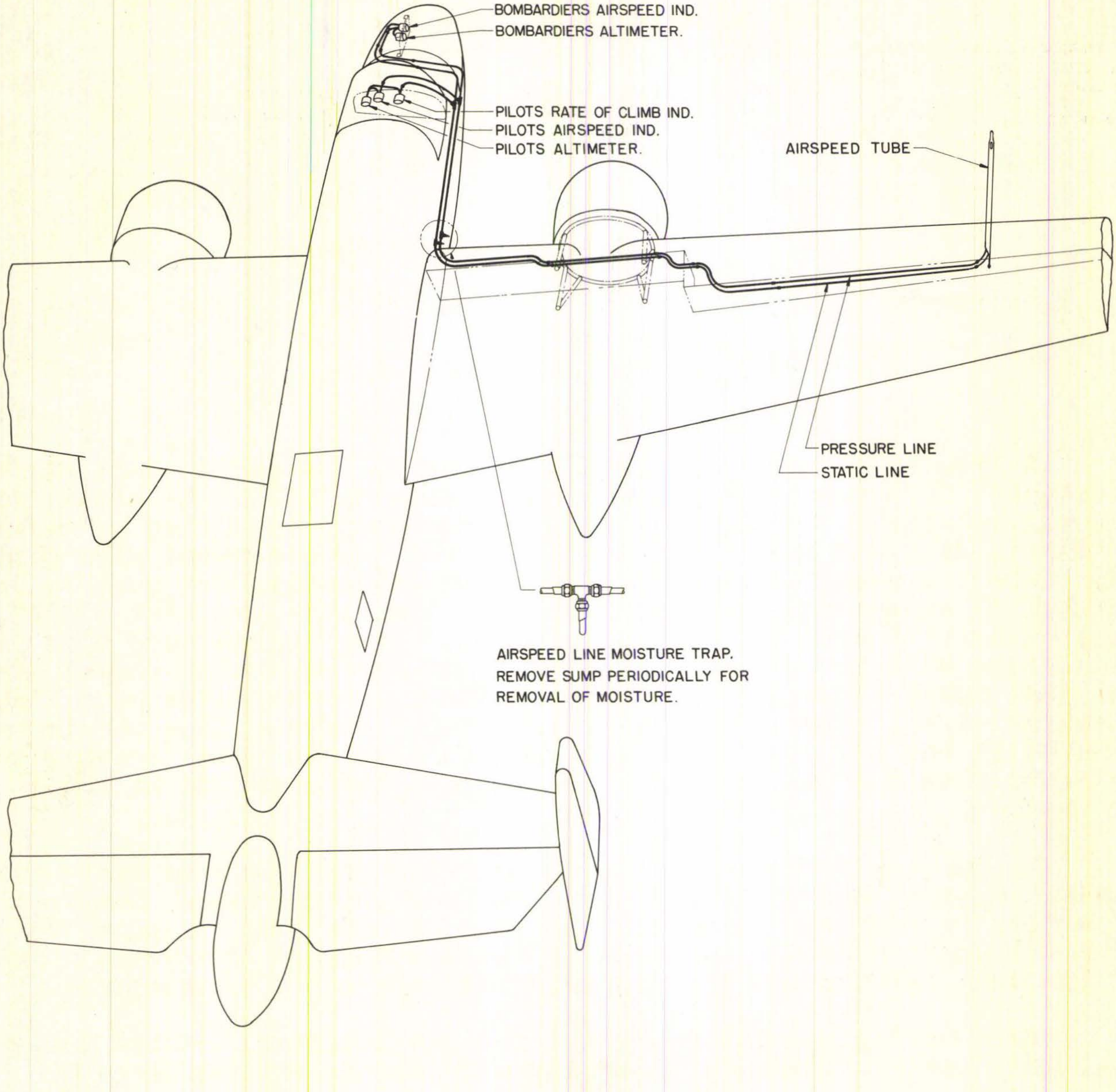


FIG. 28 (B-25, B-25A and B-25B)
AIR SPEED SYSTEM INSTALLATION

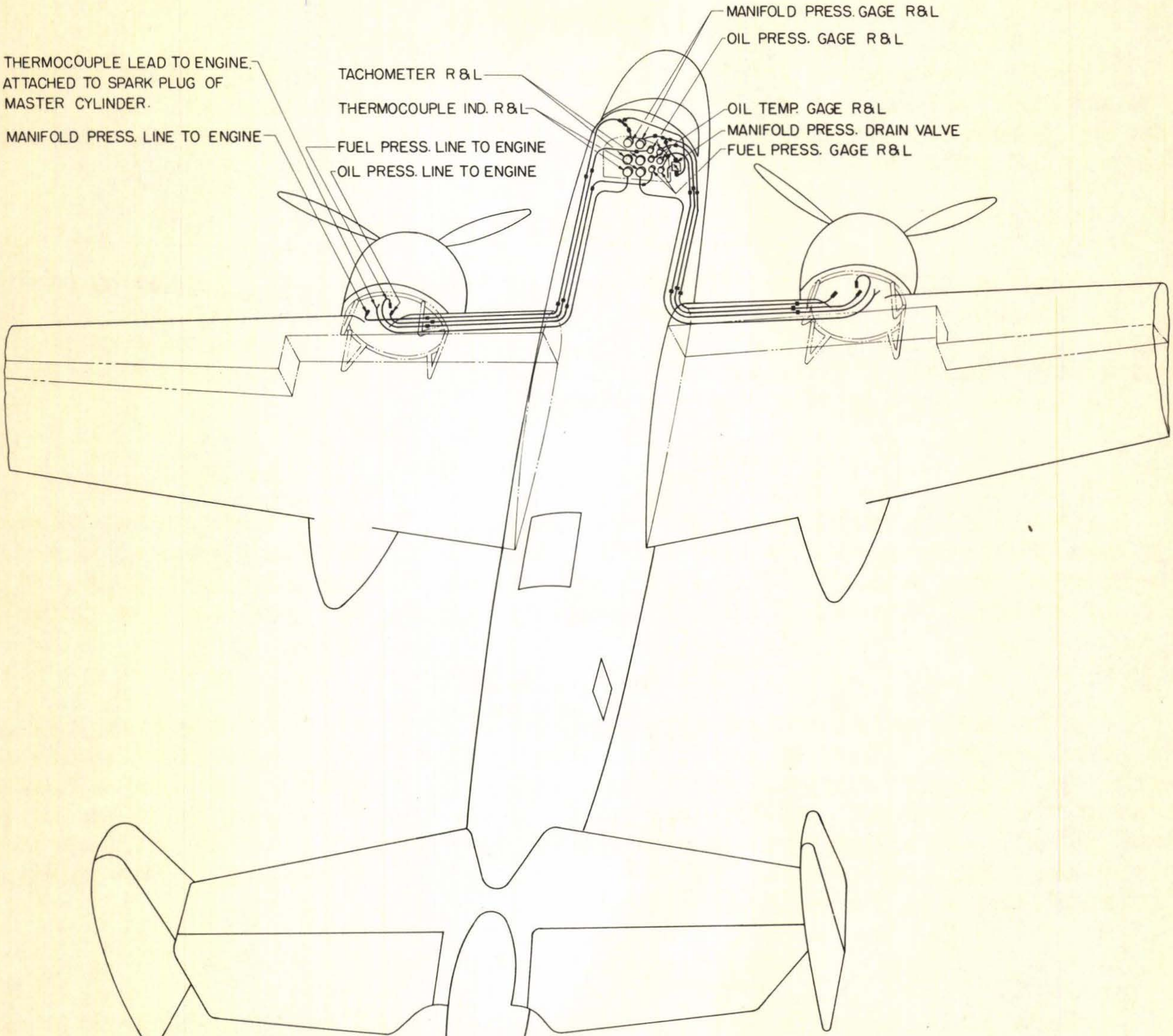


FIG. 29 ENGINE INSTRUMENT INSTALLATION (B-25, B-25A and B-25B)

terchanging for either pump rotation as did the old B-7 vacuum pumps. On the later B-12 vacuum pumps, new cases were provided without plugs on the end.

9. Engine Instruments

Because dual Indicators were not used on B-25, B-25A and B-25B airplanes, separate Indicators for each engine were installed.

10. Tachometers

Each Tachometer Indicator is electrically connected to a type E-4 electric Tachometer generator installed at each engine. The Tachometer generator is self-energizing and is not connected to the airplane's 12 volt system.

11. Manifold Pressure Gauges

Each manifold pressure gauge is connected to the intake manifold of one engine. A vent line and shut-off cock are installed at the right of the pilot's instrument panel. The vent is used to reduce internal corrosion in the manifold pressure gauges by removing moisture in the lines during the engine warm-up.

12. Fuel Pressure Gauges

One fuel pressure gauge is connected to the carburetor of each engine. There are two connections at the back of each gauge, one for fuel pressure, and one for air pressure of the intake manifold. The air pressure connection is not used, and remains open to the cockpit.

13. Oil Pressure Gauges

Each oil pressure gauge is connected to the oil pressure system of one engine. During cold weather operation, if the oil pressure gauge is sluggish, the oil pressure gauge line should be disconnected at both the gauge and at the engine and the line cleared by blowing it free of oil with compressed air. The line should then be filled with instrument oil, Specification 3563, and again connected. (For further instructions see Technical Order 05-40-10).

14. Oil Temperature Gauges

Each oil temperature gauge is electrically connected to a resistance bulb installed in the "Y" drain valve at one engine.

15. Limitation Markings of Engine Instruments
(Differences from B-25C and B-25D)

Instrument	Operating Range (Green)	Max. Permissible (Red)
Oil Temp.	46.5 - 85°C	Cautionary Markings (Yellow) at 20° - 40°C and 95° - 120°

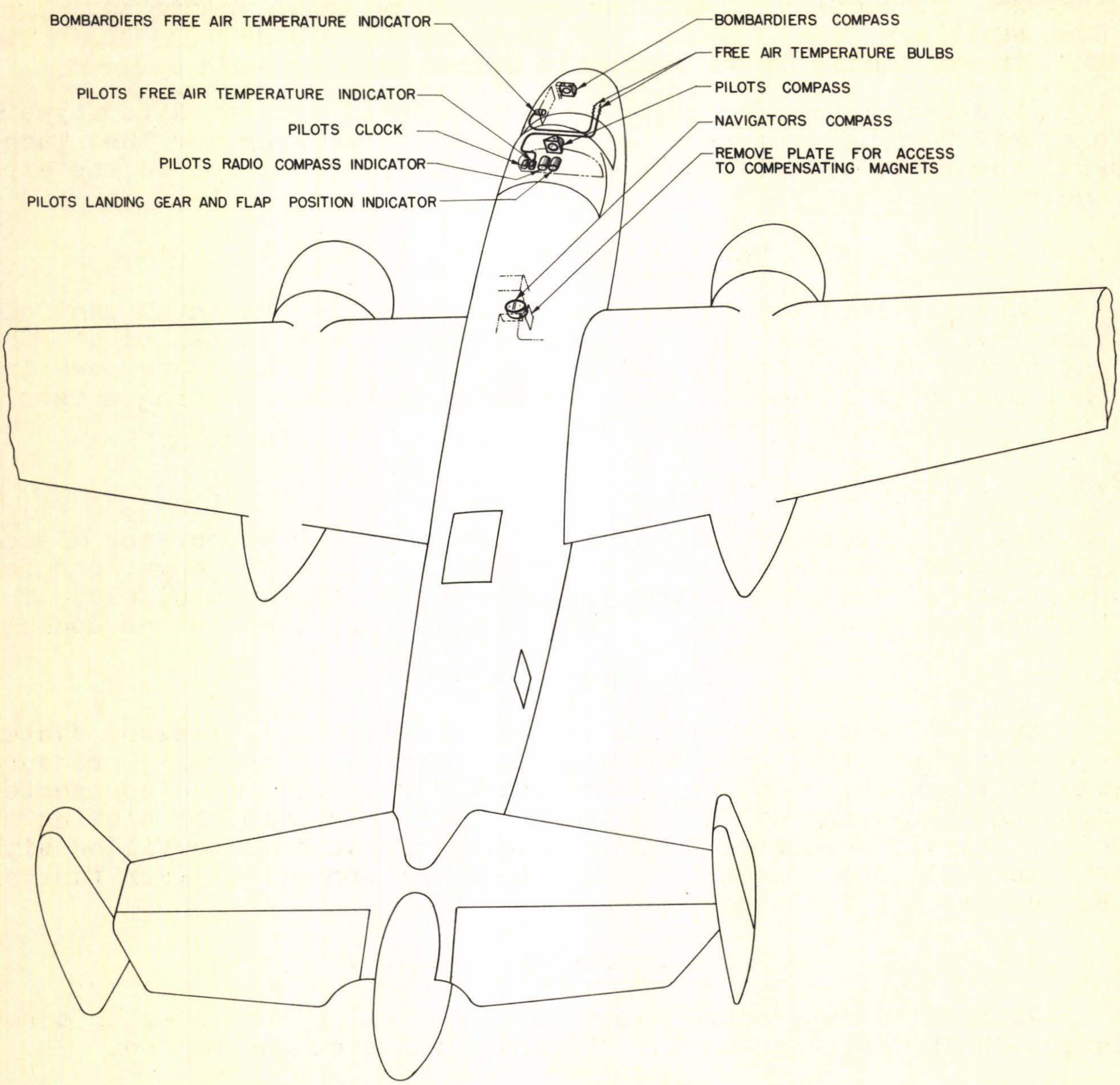


FIG. 30 MISCELLANEOUS INSTRUMENT INSTALLATION (B-25, B-25A and B-25B)

16. Free Air Thermometer

On B-25, B-25A and B-25B airplanes only, type C-6 free air temperature indicators are installed at the pilot's panel and at the bombardier's panel. Each indicator is connected by means of a capillary tube to a helical bulb installed beneath the fuselage nose. The capillary tube and helical bulb are filled with a saturated gas vapor. Consequently, extreme care must be taken to avoid injury to the capillary tube. DO NOT CUT OR BREAK THE ARMORED CAPILLARY TUBING. Excess tubing is to be neatly coiled and fastened securely.

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FORM 5-G

INTER-OFFICE CORRESPONDENCE

AVOID VERBAL ORDERS

To ______________________ Date ______________________

From ______________________ Ref. ______________________

FORM 5-G

INTER-OFFICE CORRESPONDENCE

AVOID VERBAL ORDERS

To ______________________ Date ______________________

From ______________________ Ref. ______________________

ELECTRICAL INSTALLATION

LANDING GEAR
INSTALLATION

NORTH AMERICAN AVIATION Inc.

Landing Gear LECTURE

B-25 SERIES AIRPLANES

PREPARED BY *Eric L. Martin*

NOTE

THE INFORMATION CONTAINED IN THIS LECTURE WAS CORRECT AS OF MAY 15, 1942. REFER TO HANDBOOK OF OPERATION AND SERVICE INSTRUCTIONS FOR THE LATEST INFORMATION.

THIS DOCUMENT CONTAINS INFORMATION AFFECTING THE NATIONAL DEFENSE OF THE UNITED STATES WITHIN THE MEANING OF THE ESPIONAGE ACT, 50 U.S.C., 31 AND 32. ITS TRANSMISSION OR THE REVELATION OF ITS CONTENTS IN ANY MANNER TO AN UNAUTHORIZED PERSON IS PROHIBITED BY LAW.

N A A

INGLEWOOD, CALIFORNIA

INDEX

I L L U S T R A T I O N S

MAIN LANDING GEAR GENERAL

The landing gear is operated by means of hydraulic power. The main gear and auxiliary nose gear operate concurrently when the selector valve on the pedestal in the cockpit is actuated. Moving the selector handle to the up position retracts the gear, moving it down lowers and locks the gear in landing position. For normal operation the gear should not be lowered above 170 miles per hour indicated airspeed.

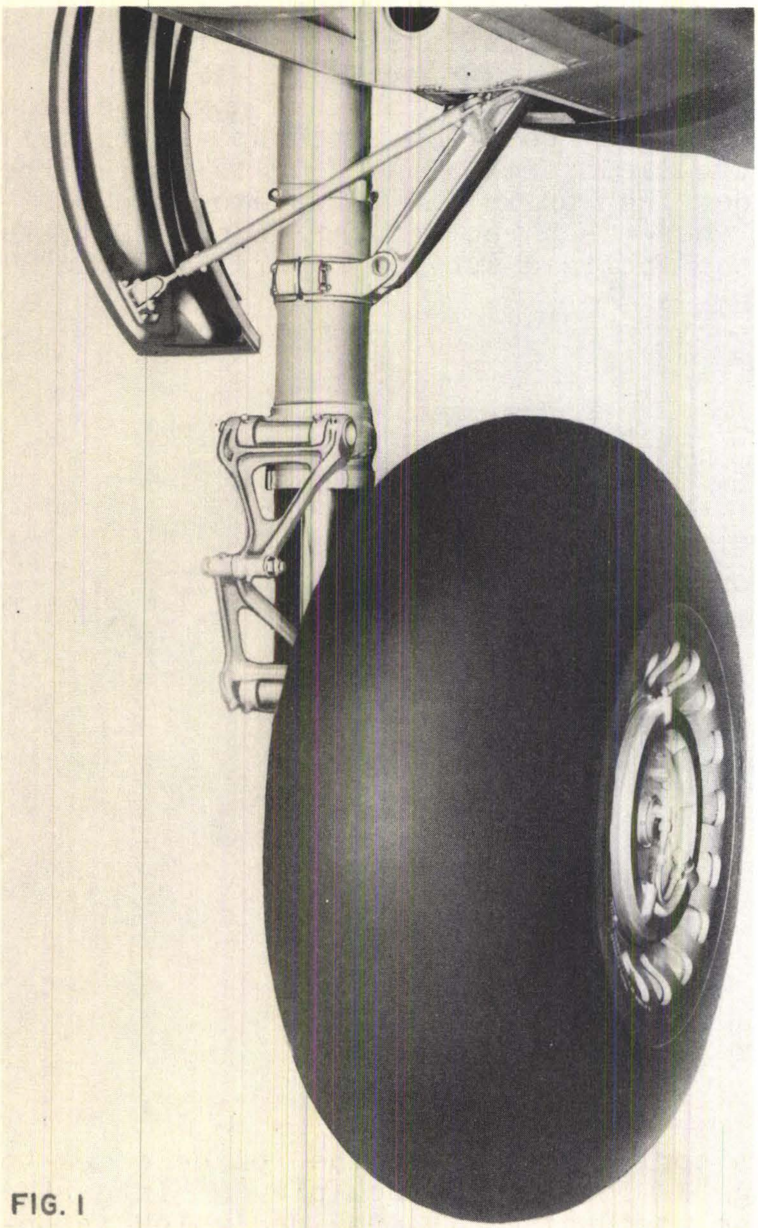

FIG. 1

DO NOT under any circumstances, move the landing gear control handle while the airplane is on the ground, as there is sufficient hydraulic pressure stored in the accumulator to retract the lock pins and cause the gear to collapse. To avoid accidental movement of the landing gear control handle, three distinctly different safety devices are provided. One is a latch on the quadrant that must be set in the correct position before handle can be moved; the second device is a wire hook that shall be placed over the handle whenever the airplane is at rest on the ground. The third safety feature is a hydraulic control lock that shall be installed over the landing gear and flap control quadrant whenever the pilot leaves the airplane. A strap for stowing the locking plate is provided in mooring and handling equipment kit in navigator's compartment.

In an emergency use mechanical lowering system. DO NOT lower landing gear by operating the hand pump with emergency selector valve on "NORMAL"; for if the loss of general hydraulic system pressure were caused by a broken line, it would be impossible to move the gear, and the fluid reserve needed for hand pump operation would be pumped overboard by the hand pump.

MAIN LANDING GEAR OPERATION

When the landing gear selector handle is moved to the up position, pressure is first applied to the extended position lock pin operating cylinder "A" (See Fig. 2). The lock pin "B" is then withdrawn and a timing valve "C" is actuated, which applies pressure to the oleo retracting cylinder. The oleo leg then pivots about the trunnion point until the retracted position latch engages and locks the gear in the retracted position.

The retracted position latch is spring loaded and is actuated by a roller on the oleo leg. The latch rotates on a shaft which is supported by means of a truss from two fittings bolted to the wing at the rear spar.

When the selector valve handle is moved into the down position, pressure is applied to the retracted position latch operating cylinder, which disengages the latch and permits the gear to fall. The landing gear operating cylinder then pulls the gear into down position. On top of the oleo leg there is a rectangular blade "D" (see Fig. 2), which moves against the inclined surface of the lock pin "B",

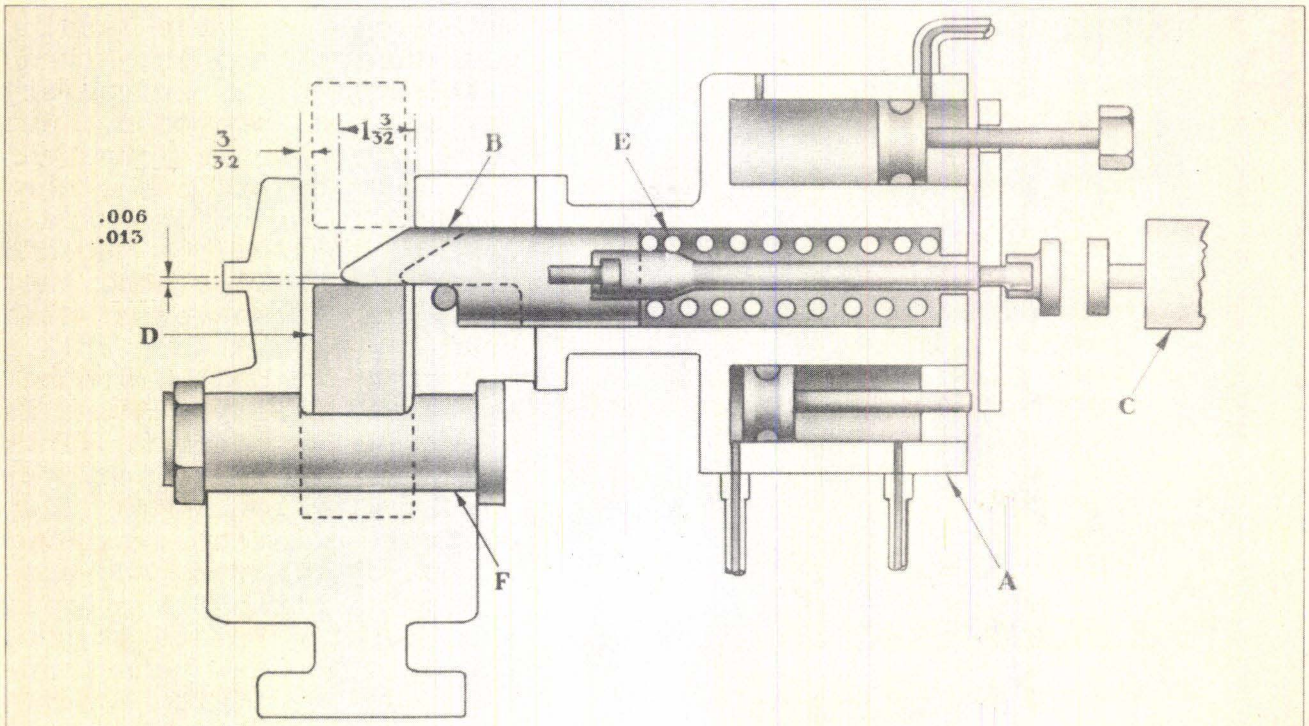

FIG. 2 DOWN LOCK

which forces pin back against spring "E". When the blade comes to rest against stop "F", spring "E" forces the lock pin "B" into the locked position. An indicating mechanism is provided which is operated by both the blade and the lock pin, thus when the gear is down and locked the indicators on the pilot's instrument panel will register as such. This system is also hooked up with the warning horn which will sound when the throttles are closed, if the gear is not down and locked.

MAIN GEAR EMERGENCY MECHANICAL OPERATION

The emergency lowering system for the main gear consists of a mechanism located just aft of the bomb bay and a cable running from the mechanism through the tail ribs aft of the rear spar to an arm mounted on the landing gear trunnion (See Fig. 3).

WARNING: DO NOT lower the main landing gear by means of these emergency mechanical lowering systems above 150 miles per hour indicated airspeed and with airplane in level or preferably gliding attitude.

The screw jack provided for lowering the main gear is very powerful, and if the handle continues to be turned after the gear is down and locked, damage to the cable may result. When the emergency system is used, contact between the pilot's compartment and the operator should be made on the interphone system so that when the gear locks, the screw can be backed off and the emergency system returned to the stowed position.

The sequence for operating the mechanical lowering system is as follows:

1. Move landing gear selector valve to down.
2. Release main landing gear operating screw assembly (held to forward wall of radio compartment with finger type dzus fastener) and rotate assembly to fore and aft position.
3. Pull main landing gear up position latch release located adjacent to lowering screw. This control releases the main gear up position latches only, and allows the main gear to partially lower due to its own weight.
4. Turn lowering screw handle clockwise (when facing handle) until indicators register that the main gear is down and locked. When the wing nut is turned the screw jack moves out of the housing and pulls in the cable looped around the equalizing pulley. Taking in the cable lowers the main gear.
   NOTE: The main gear cannot be raised mechanically.

MAIN GEAR EMERGENCY MECHANICAL LOWERING MAINTENANCE

At the regular 50-hour inspection of the landing gear, inspect the following:

1. Main lowering and lock release cables and pulleys.

2. The operation of the emergency lowering system.
   WARNING: Set landing gear selector valve, in pilot's compartment, to "DOWN" position. DO NOT retract gear with jack screw out.

   (a) With the gear in the up position the main gear emergency lowering cable should not be under tension in excess of 120 pounds.

(b) With doors connected and operating, approximately 2-1/4" of screw threads should be left when the gear is down and locked.

(c) If, after one gear is down and locked, the other gear does not lock within four (4) complete turns of the handle, an investigation should be made. The difficulty may be that one nacelle door is rigged excessively tight, a lock pin may be stuck, or a cable or pulley binding.

3. Lubricate needle bearings in arms on landing gear trunnion, and jack screw as specified in handbook.

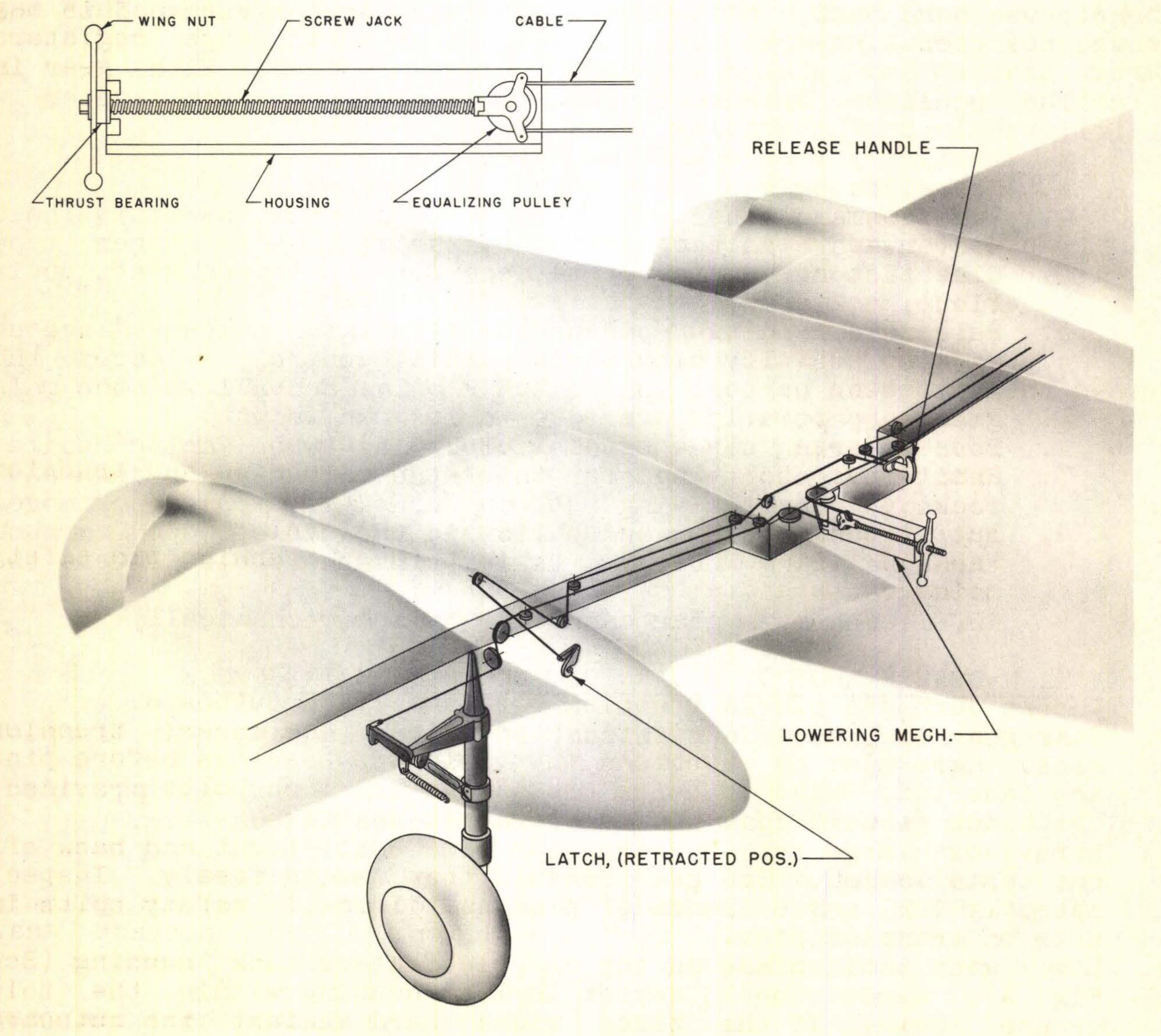

FIG. 3 MAIN GEAR MECHANICAL LOWERING MECHANISM

REMOVING MAIN LANDING GEAR

The main landing gear is supported below the wing center section by means of three aluminum alloy forgings and two tubular drag struts (See Fig. 4).

The forgings form a pivot point perpendicular to the plane of symmetry. The drag struts are attached to the front spar at one end and the trunnion at the other. The trunnion fitting on the oleo assembly completes the structure.

Jack up the ship with special wing jacks, using outboard jack points. Jacks should be placed in position to obtain clearance on the landing gear doors when gear is retracted.

To facilitate handling of the gear, the wheel and brake assembly may be removed. The following procedure should be followed:

First put landing gear control handle in up position; if there is any pressure in the accumulator the gear will partially retract: if not, use hand pump. Release all pressure from system. This may be done by operating cowl flaps or wing flaps until gauge registers zero. Exhaust accumulator with dump valve provided. With gear in a vertical position, disconnect the following:

1. Main door operating strut to torque shaft.
2. Auxiliary door operating strut.
3. Brake lines.
4. Position indicator rod.
5. Hydraulic retracting cylinder.
6. Oleo side brace strut.
7. Place jack under oleo on point provided.
8. Release air pressure from oleo strut.
9. Jack up to fully compressed position.

Remove the following parts:

1. Emergency lowering arm.
2. Loosen large nuts on each trunnion pin.
3. Remove two half-inch bolts through trunnion and trunnion pins.
4. Pull trunnion pins, using nuts as pullers.
   WARNING: DO NOT use drift pin through trunnion pin safety holes on thread area.

INSTALLING MAIN GEAR

1. Insert outboard pin in trunnion with small end outboard.
2. Jack gear in place, in vertical position, and insert trunnion pins. Care must be exercised in lining up bearings before pins are inserted. Line up bolts and insert 1/2 inch bolts provided. Use block to hold lock pin in retracted position.
3. Screw down large nuts on trunnion pins until tight and back off one castellation. The gear should then swing freely. Inspect assembly for any evidence of binding. Install safety bolts in nuts on trunnion pins.
4. Lower gear until blade on top of oleo enters lock housing (See Fig. 4). Blade should center in lock housing within the tolerance shown. If the blade rides hard against the outboard side of the lock housing, add a large steel washer of required thickness to outboard trunnion pin between landing gear and sup-

port bearing. If the bearing rides hard against the inboard side of the lock housing, it may be necessary to add a sheet metal shim between the lower surface of the wing and the center diagonal brace strut to obtain the proper clearance.

5. Put landing gear selector valve in gear down position. Push landing gear down until lock snaps in place. The action of the lock should be free and "snappy". If the pin action is slow or sluggish, inspect for binding or presence of foreign matter, sand, burrs, etc. In case of extreme cold weather lubricate with light oil to prevent congealing.

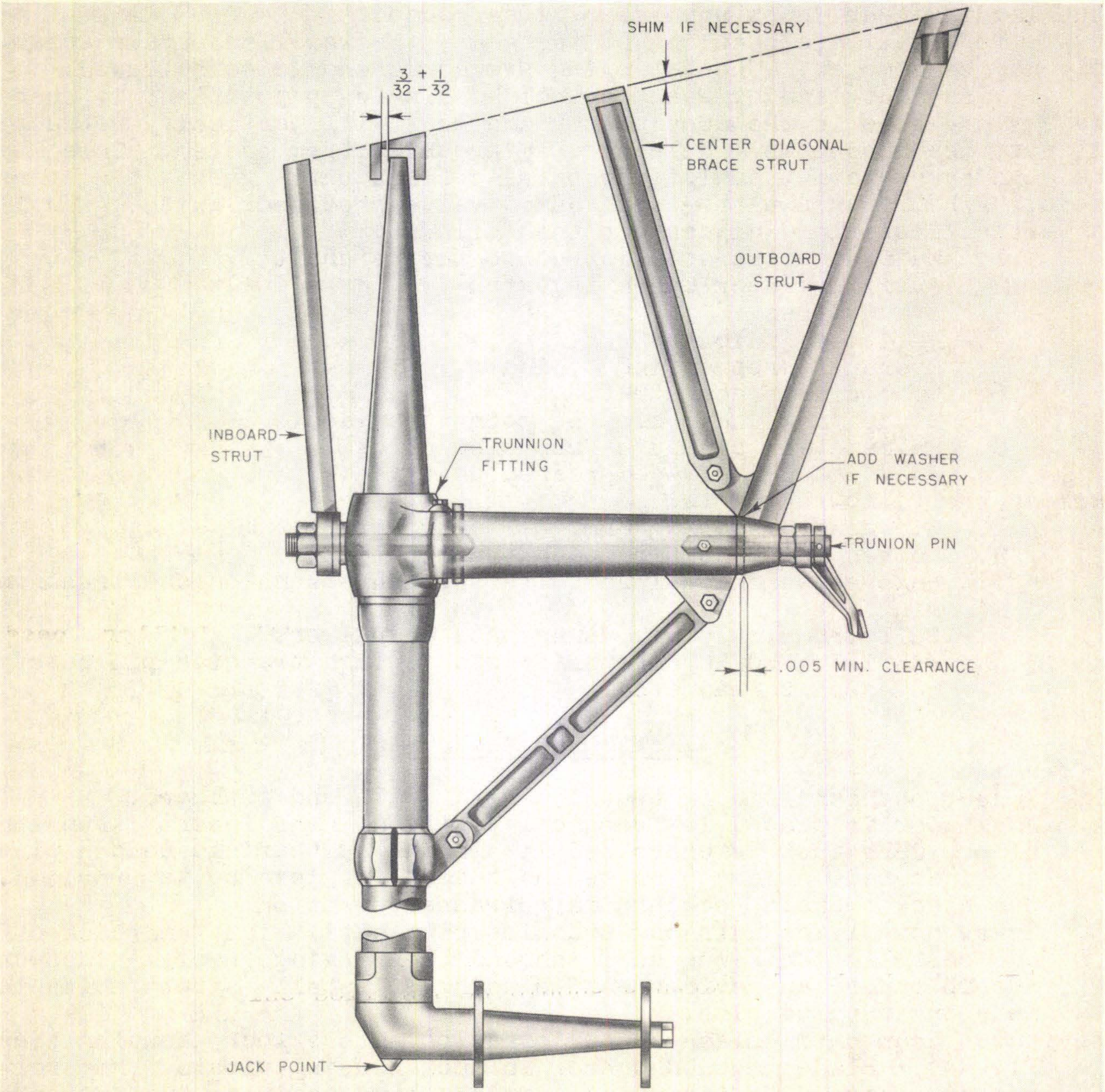

FIG. 4 MAIN GEAR INSTALLATION

6. With blade "D" hard up against the stop "F" (See Fig. 2), the clearance between the blade and the lock pin should be .006 inches minimum to .013 maximum. Check this clearance with feeler gauge--about .010 inches is the desired clearance. Faces should be square. It will be noted that pin "B" and stop "F" have a slight degree of freedom in rotation, this is to allow alignment with the blade "D".
7. Attach retracting cylinder and retract gear by means of hand-pump or hydraulic test stand.
8. Check alignment of up position latch on latch roller on oleo. If the latch does not center on the roller, move latch in direction desired by rearranging washers provided on the latch support.
9. The gear should be retracted and extended several times to check proper functioning. If the doors are in place care should be taken to prevent their being damaged by the gear.
10. Attach brake line hose.
11. Connect doors and check for operation.

INSTALLING MAIN LANDING GEAR RETRACTING CYLINDER

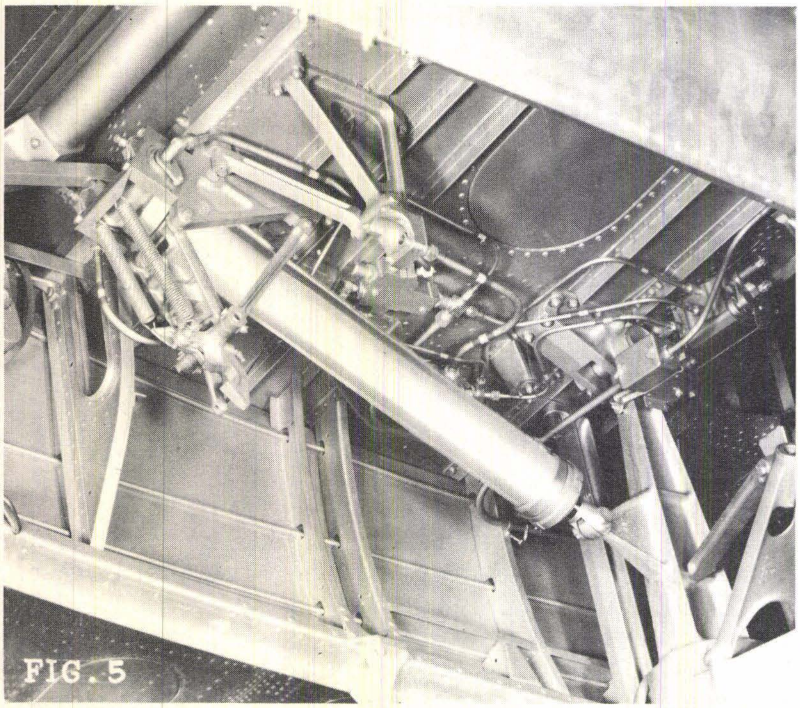

FIG. 5

For installing main landing gear retracting cylinder, a special No. 62-33628-2 and 62-33628-3 shim is provided to be placed between the attaching blocks and the support fittings. The purpose of this shim is to align the end of the piston with the main gear. The support blocks are attached to the fittings with drilled head bolts and special circular nuts through the fittings. Holes are provided through these nuts for checking length of thread of the bolt in the nut.

SERVICING MAIN LANDING GEAR AND NOSE GEAR SHOCK STRUTS

The shock absorber struts should be refilled only when there is an indication of oil leakage. With struts fully compressed, fill with fluid conforming to Air Corps Spec. 3580. Inflate main landing gear shock struts to a distance of 2-7/8 inches, as shown on instruction plates attached to the struts. WARNING: Both shock struts must be inflated to the above distances with the airplane loaded for flight and without the weight of the crew.

LANDING GEAR WARNING SIGNALS

Landing Gear Controls:- There are three ways to ascertain that the landing gear down position latches are in place, safe for landing (1) Latch indicator (red flags) on position indicator instrument (in pilot's compartment only) should not be visible. (2) Warning horn should not sound. (3) Placing airplane in climb should not register movement of the gear on position indicator instrument. The time required for normal operation of the landing gear is approximately 11 seconds for lowering and 22 seconds for raising.

A position indicator for the landing gear, landing gear down position locks and wing flaps is provided on the pilot's instrument panel. The actual movement of the landing gear and wing flaps is indicated pictorially while the locked-down position of the gears is ascertained when red flags on instrument are not visible.

When either throttle is retarded beyond a point approximately 3/4 inch from the fully "CLOSED" position, and the landing gear is in any position other than the locked-down position, an electric warning horn sounds and will continue to sound and warn of any unsafe landing condition until the landing gear is in the fully locked, down position. A release switch is provided to render the horn inoperative during one engine or closed throttle maneuvers. Opening throttle automatically reinstates the warning horn.

Due to complexity of procedure to be followed in adjusting main landing gear position transmitters, throttle switches, and main landing gear lock pin switches, we will omit them in this lecture but wish to call your attention to the fact that they are described in detail in the Manual for Service and Maintenance.

WHEEL AND BRAKES

The main landing gear is equipped with Goodyear 47-inch S. C. wheel, type II-A puncture seal tubes, and dual disc brakes. The brakes are normally hydraulically operated from the general hydraulic system through conventional toe type pedals mounted in both the pilot's and co-pilot's rudder pedals. For parking, the brakes may be locked in the applied position by a control handle provided.

An emergency pneumatic brake system is provided. The system consists of an air pressure storage tank in navigator's compartment, an automatic shuttle valve on each brake assembly, and an air valve controlled by a lever accessible to pilot and co-pilot. The air pressure storage tank is provided with a gauge and can be recharged from ground only. An air pressure of 550 to 600 ~~400 lbs.~~ should be maintained in tank at all times. This pressure is applied directly to brake operating plates when system is operated. The function of the shuttle valves is to shut off any leakage of air through deboosters and hydraulic brake system when emergency system is in use. Lines of the emergency system are as widely separated as possible from hydraulic brake lines. Whenever the emergency pneumatic brake system has been used, it is necessary to thoroughly bleed the brake hydraulic system.

Use air pressure brake system in an emergency only.

TAIL SKID

The tail skid on the B-25C and subsequent airplanes is a pressed steel shell, attached rigidly to a beam assembly of the fuselage main structure. The shell is .078 pressed steel sheet and has provisions for a mooring ring. The shell is attached to the beam assembly by four (4) - 3/8" bolts and may be removed for repair or replacement.

NOSE WHEEL OPERATION

The nose wheel operates concurrently with the main gear. When the selector valve handle is moved to the up position, hydraulic pressure is applied simultaneously to the "Down Latch" and the retracting cylinder. The retracting cylinder pulls up on the brace truss and the gear retracts up into the wheel bay. A spring-loaded latch locks the gear in the up position.

When the selector valve is moved to the "Down Position", hydraulic pressure is first applied to the up position latch timing valve. The latch releases and trips the timing valve allowing pressure to be applied to the operating cylinder. The gear then lowers and is locked in the down position by means of a similar type latch.

NOSE WHEEL EMERGENCY MECHANICAL OPERATION

The emergency lowering system for the nose gear consists of a mechanism, a cable, pulleys, and pulley brackets. The cable runs from the mechanism in the navigator's compartment down through the floor and forward through the fuselage frames beneath the bombardier's tunnel, and attaches to the nose gear hydraulic operating cylinder.

A clock type spring is attached to a shaft which in turn is attached to the drum on which the cable is wound. The spring is installed so that the drum tries to turn clockwise, thereby putting tension on the cable.

When the nose gear is retracted, the cable is unwound from the drum and the spring is wound up. When the gear is lowered by the hydraulic cylinder, the spring causes the drum to rewind the cable. This cycle is repeated everytime the nose gear is raised and lowered.

WARNING: Do not lower nose gear by means of the mechanical lowering system above an indicated airspeed of 150 MPH. The airplane should be level or preferably in a gliding attitude.

The sequence to operate the mechanical lowering system is as follows:

1. Move landing gear control handle in pilot's compartment to "down" position.

2. Pull nose gear emergency lock release located on top of mechanism. This releases the nose gear and allows it to lower partially due to its own weight.

3. Remove safety pin and turn pawl to "on" position.

4. Place crank, stowed at side of mechanism,on shaft and turn clockwise until gear indicator registers down and locked. It is safe to land the airplane with the down lock not engaged if the following conditions are fulfilled:

   (a) The position indicator shows the gear to be in its farthest down position.
   (b) The tension in the cable is as great as can beapplied with the hand crank.
   (c) The pawl is engaged.

WARNING:- After lowering nose wheel in the above manner it is imperative that the pawl control be returned and safetied in the "OFF" position, and the handle stowed on side of drum housing, before attempting to retract nose wheel again.

CAUTION:- Do not return pawl to "OFF"position until ship is safely on ground. Otherwise the operation of the main gear is liable to set up a surge in the hydraulic system which will cause the nose wheel down position lock to release allowing the nose wheel to partially retract.

NOSE WHEEL EMERGENCY MECHANICAL LOWERING MAINTENANCE

At the regular 50-hour inspection of the landing gear, inspect the following:

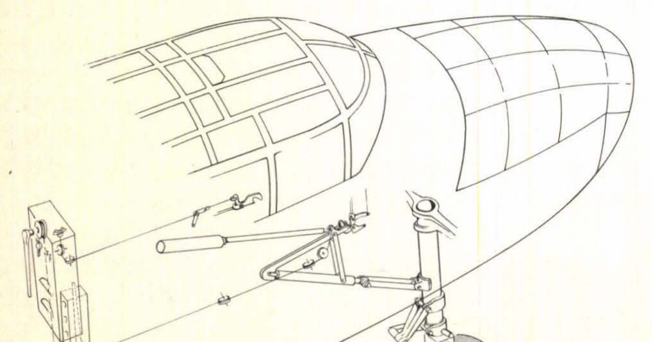
FIG. 6

FIG. 7

1. Nose gear lowering and lock release, cables and pulleys.

2. The operation of the mechanical emergency system.

3. If the mechanism or cable is replaced, care should be taken to install so that sufficient tension is on the cable.

NOSE WHEEL WARNING SIGNAL SYSTEM

Due to complexity of procedure to be followed in adjusting nose gear lock latch switch we will omit it from this lecture, but wish to call your attention to the fact that it is described in detail in the manual for Service and Maintenance.

NOSE WHEEL INSTALLATION

The nose wheel is installed as follows: The nose wheel chassis assembly is placed under the trunnion support fitting, at station 70 and raised into position, having the right side slightly aft. When the left side is in line with trunnion hinge pin hole, push the right side in line with hinge hole. Insert hinge pins and attach lock bolt and nuts. Tighten trunnion nuts finger tight and back off one castellation before safetying. After assembly check down position lock alignment by operating gear. Make certain lock has 1/16" clearance on each side. In the up position wheel should clear bottom of pilot's floor by 13/16".

INSTALLING NOSE WHEEL RETRACTING STRUT

Install retracting cylinder to upper fitting and check alignment at brace truss lugs. If the bolt and lugs at the brace truss connection do not line up, insert necessary shims (25-33567-2 and 25-33567-3) under bearing block at upper end to obtain proper alignment.

SERVICING NOSE WHEEL SHOCK STRUT

The shock absorber strut should be refilled only when there is an indication of oil leakage. With strut fully compressed, fill with fluid conforming to Air Corps Spec. 3580. Inflate nose wheel shock strut to a distance of 5-3/16 inches, as shown on instruction plate attached to the strut. WARNING: Shock strut must be inflated to the weight of the crew. A final check for nose wheel shock strut inflation should be made after moving tail of airplane up and down several times and allowing strut to assume its normal position.

NOSE WHEEL TIRE

The nose wheel is equipped with a Hayes 30-inch wheel and a dual-seal (Lifeguard) tube. A cross section diagram of this tube is shown on Figure 8. This tube is quite different from the conventional tube, in that the air for supporting the tire is confined in two compartments instead of one. In this two-compartment arrangement, the cover of the outer compartment, being made of high quality rubber compound, inflates tightly against the inside of the tire and provides resiliency and durability required from a conventional tube.

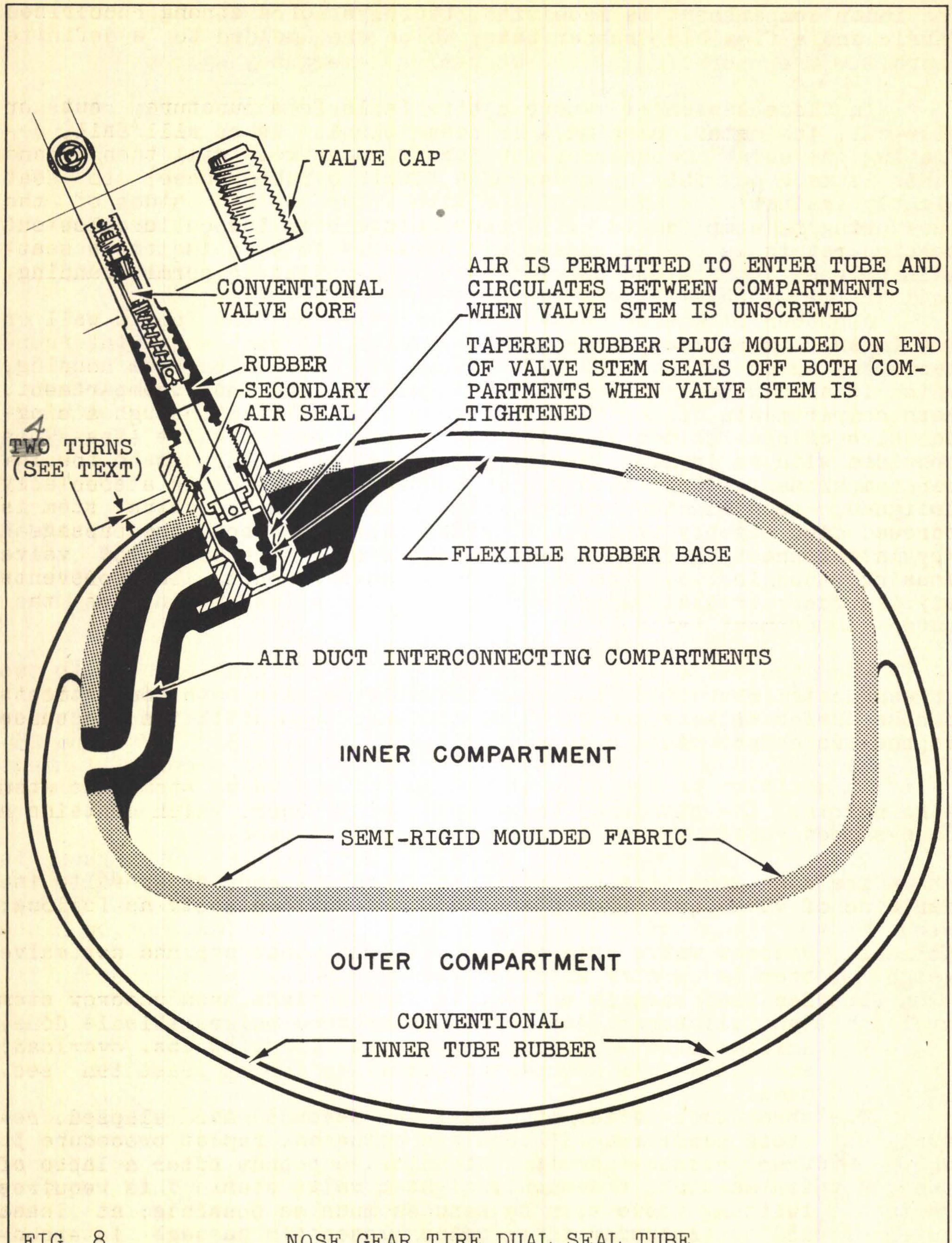

FIG. 8 NOSE GEAR TIRE DUAL SEAL TUBE

The inner compartment is made with two plys of a strong rubberized fabric and a flexible rubber base, which are molded to a definite shape.

In those instances where a tire fails from puncture, cut or blow-out, the outer covering, or conventional tube, will fail, deflating the outer compartment.The inner compartment will then expand (this is made possible by means of a flexible rubber base) to seat tightly against the inside of the tire. The top and sides of the tube being made of fabric, will thus bridge over the cut or blow-out section,retaining the necessary air pressure to keep the tires seated firmly on the rim and provide a rolling radius to permit landing.

A rubber extension molded on the inside of the fabric wall or the inner compartment is provided with an air duct which interconnects the outer compartment of the tube with the valve stem housing, which is also molded onto the fabric wall of the inner compartment. Both compartments of the dual-seal tube are inflated through a single valve of special design. The main barrel of the valve (brass) is provided with an opening leading almost directly through to the inner compartment.Molded onto the end of the valve stem is a specially designed, tapered hard rubber plug which, when the valve stem is screwed down tightly into its housing, closes off both the passageway interconnecting the two compartments and the end of the valve housing, thus locking the air in both compartments. This prevents any further circulation of air between compartments in case the outer compartment fails.

When the valve stem is screwed out of its housing one to two threads, air introduced through it will flow into both compartments of the dual-seal tube and circulate between them until the pressures in the two compartments become equalized.

In addition to the plug at the end of the valve stem, the stem also carries the standard valve core, or plunger, which contains a cone-shaped rubber washer molded onto a swivel base.

The nose gear tire inflation instructions are attached to inner side of wheel hub cover plate, and are substantially as follows:

1. Unscrew valve stem cap,ascertaining that cap and not valve stem is turning while so doing.
2. See that stem is screwed in finger-tight,then unscrew stem ~~two~~ FOUR full turns.(Air cannot enter tube unless this is done.)
3. Inflate tire 45 lbs./sq.in. normal load;(49 lbs. overload) and allow this pressure to equalize for at least ten seconds.
4. IMPORTANT:- After at least ten seconds have elapsed, recheck pressure. If loss has occurred, repeat procedure 3. When pressure remains at 45 or 49 pounds after a lapse of ten seconds, thoroughly tighten valve stem. This requires twisting valve stem by hand as much as possible; at least 180°. (Screwing in on valve closes air passage interconnecting compartments,making possible the dual-seal arrangement.)

5. Test for valve leaks by spit test.
6. Install valve cap and wheel hub plate.

Warning:- Do not use the inflation ribs on the nose wheel tire to indicate the proper inflation.

It is extremely important that equalized pressure be maintained in both compartments of dual-seal tube at all times. To accomplish this, it is necessary to loosen the valve stem two turns each time the tube is inflated or a pressure check is made. Regardless of the amount of air added to a tire that has gone down, it is absolutely necessary to wait for this pressure to equalize between compartments before tightly screwing in valve stem.

Due to the abnormal strains to which a dual-seal tube will be subjected when a landing is effected on a blown tire, the tube should never be re-used after being landed in a cut or blown-out tire.

DATA FOR MOUNTING TIRE

1. Work first bead of tire onto wheel.
2. With valve stem removed, work tube into tire.
3. By use of a Schrader valve extension No. 6358, inflate the tube slightly.
4. Unscrew valve extension and work other bead of tire onto the wheel, with the valve stem housing in line with rim hole.
5. Quickly screw in Schrader valve extension and inflate tube to about 20 pounds. Center the valve.
6. Unscrew valve extension and screw in valve stem two turns and inflate.

NOTE:- In order to facilitate in the normal shaping that takes place within a new or newly installed tire, it is recommended that the tire be deflated to about 20 pounds and reinflated a few hours after it is mounted.

Removal of Valve Stem From Wheel:- If the air should leak from the outer air chamber, the inner chamber will expand and cause the valve stem to be drawn inside the rim. This condition makes it impossible to relieve the pressure from the inner chamber to deflate tube. In order to bring the valve stem through the hole, the following operations should be performed:-

1. Procure a short piece of tubing that is a tight fit in valve stem hole in wheel.
2. Attach tubing to a high pressure air line.
3. Insert end of tubing in valve stem hole in wheel and apply air pressure to inside of casing.
4. This should bring end of valve stem in line with hole so that it may be pulled through hole.
5. Remove valve stem and tubing.

SHIMMY DAMPER GENERAL

A hydraulic damper (see Figure 9) was developed to prevent shimmy which is inherent in all castering type wheels. The damper is attached securely to the front of the shock strut, and through the arm "A" and link "B" it connects to the upper torque link collar lug "C".

The lower torque link collar "D" has a tow lock pin "E" which "AT ALL TIMES MUST BE LOCKED IN PLACE", except when towing. If the tow lock is not in place, the wheel is disconnected from the shimmy damper, and is free to rotate. When this latter condition exists, a violent shimmy will result, which will become dangerous and may cause a failure when taxying.

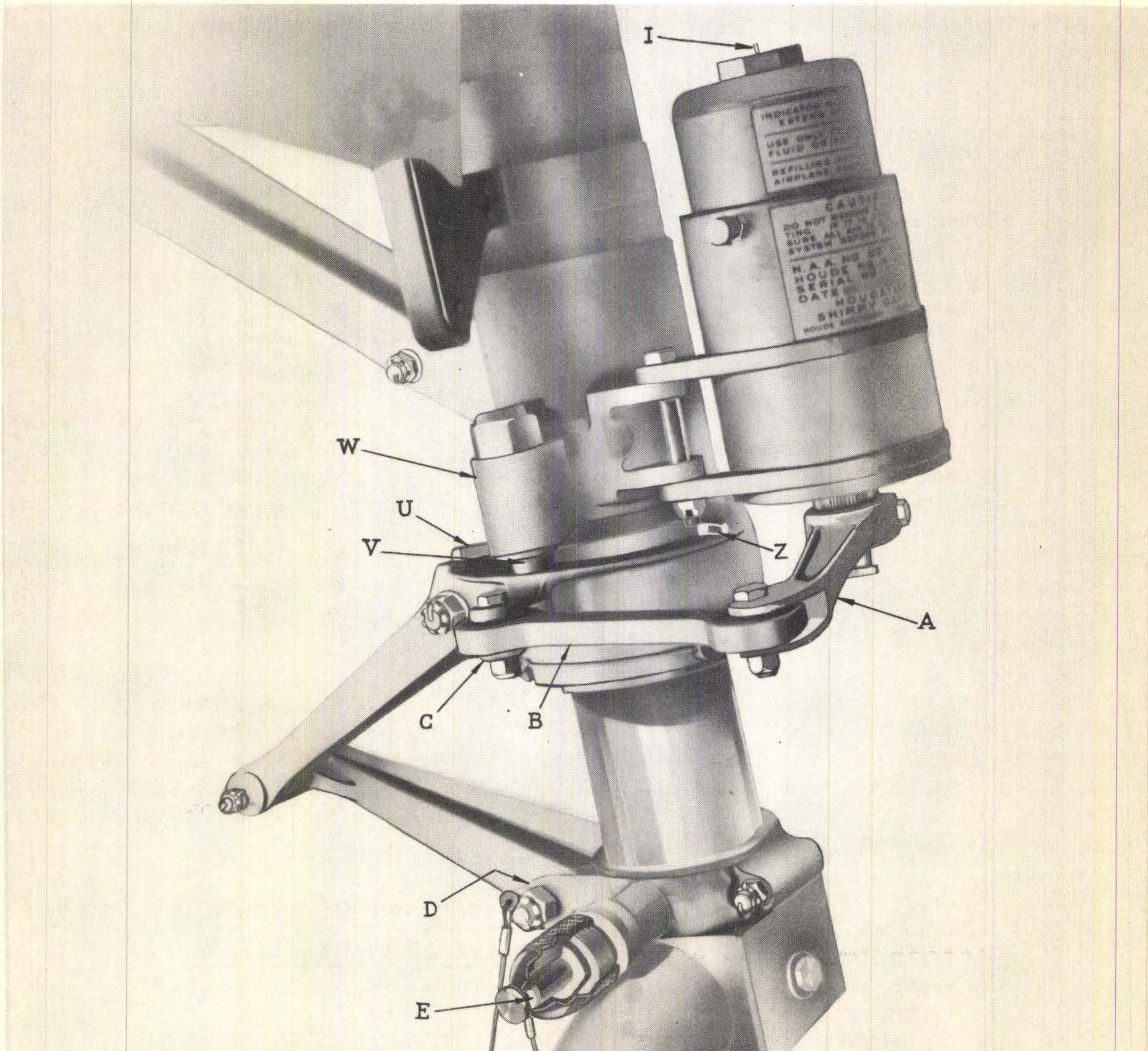

FIG. 9 SHIMMY DAMPER INSTALLATION (B-25C)

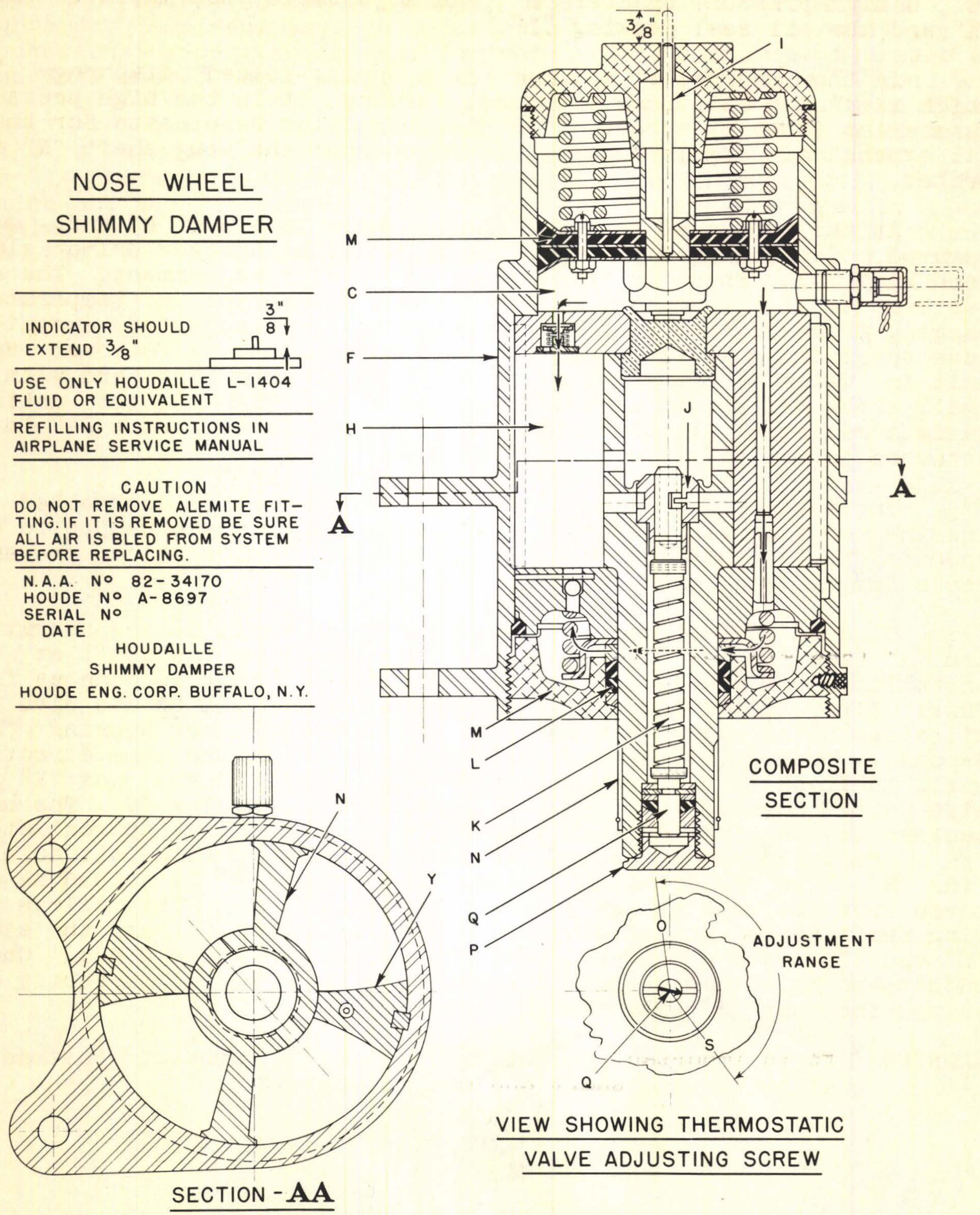

FIG. 10 SHIMMY DAMPER SECTIONAL VIEW (B-25C)

The internal mechanism and functioning of the damper is as follows, (see Fig. 10): A housing "F" enclosing an oil reservoir "C", a high pressure chamber "H", an adjustable thermostatic valve "K" and the oil seal packing "L".

In the reservoir chamber is a spring-loaded diaphragm "M" which keeps the oil under pressure, forcing it in the high pressure chamber as shown by arrows. The diaphragm also compensate for thermal expansion. In the high pressure chamber the wing shaft "N" operates.

At the bottom of the wing shaft, there is a nut "P" and, when removed, it exposes a 1/4 inch shaft "Q" with a screw driver slot, (see Fig. 10). This is the thermostatic valve adjustment. The adjustment as it leaves the factory is set to operate in temperature ranging from -50°F to +120°F and should not be readjusted, except in case the packing is replaced. In such case adjust as follows: Heat unit in water at +90°F for 1/2 hour. Remove nut "P" and with a small screw driver and in the range shown on Fig. 10, set until a maximum resistance is obtained. To test resistance, use a 24" lever attached to arm "A" (see Fig. 13).

The actual operation of the shimmy damper is controlled by the thermostatic valve orifice "J". When a shimmy attempts to set up, the oil is forced through the thermostatic valve which prevents the shimmy action.

Clamped on the serration of the wing shaft is the operating arm "A" (see Fig. 9). This arm must be located on the shaft at the installation of the damper to the shock strut. This is done as follows: First unlock tow pin "E" and push torque link to one side until stop "U" contacts the boss "V" on centering lock housing "W". Second: Push shimmy damper operating arm "A" in the same direction until it stops by the contact of the wing shaft "N" and dam "Y" inside unit. Connect link "B" to torque link collar lug "C". The bolt centers on the link "B" should be short of connecting, approximately 1/4". Pull the operating arm "A" back to line up with bolt hole in link "B". If the operating arm is more than 1/4" it should be removed from the unit and replaced within this limit. This allows the wing shaft to be pulled away from the dam slightly, and the stops "U" and "Z" act as stops instead of the wing shaft and dam. Check adjustment by moving torque links to other side and if correctly adjusted the stop "Z" will contact boss "V".

WARNING: It is important that stops "U" and "Z" contact instead of allowing wing shaft and dam to contact.

SHIMMY DAMPER SERVICE AND MAINTENANCE

CAUTION: Damper must be full of fluid at all times. The damper SHOULD NOT BE DISASSEMBLED! The most important thing to watch is the red indicator rod (I), Fig. 9. It must extend $3/8 \pm 1/8$ inch above top surface of cap at all times, see Figure 10. If it extends above or below, it may be adjusted as follows:

To lower indicator rod:

1. Remove cap from Alemite fitting on side of shimmy damper, insert needle in Alemite fitting and hold until sufficient pressure is relieved to lower indicator rod the required amount.

2. Replace Alemite fitting cap, tighten securely, and safety with lockwire.

To raise indicator rod:

1. Thoroughly clean an ordinary hand-operated Alemite grease gun and fill gun with No. 1404 Houdaille Fluid. This fluid may be purchased from Houde Engineering Corporation, Buffalo, New York. If this fluid is not available, castor oil may be substituted in an emergency.

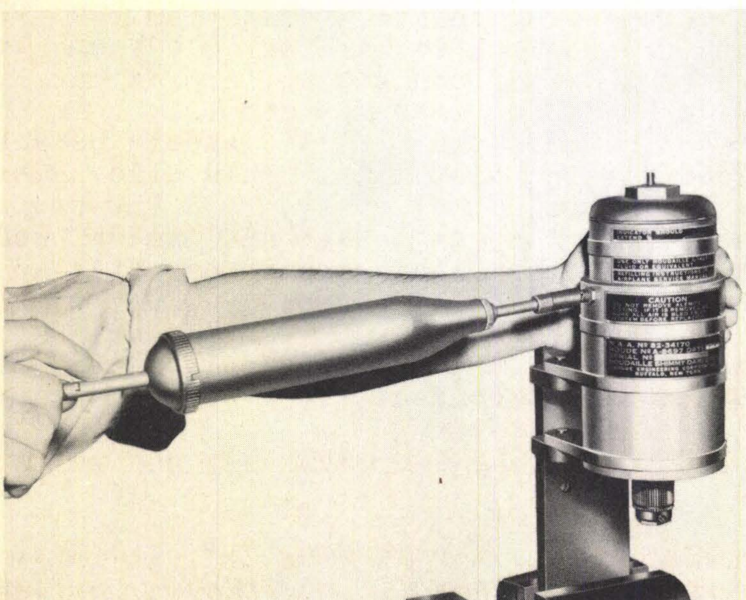

FIG. 11

2. Fill damper through Alemite fitting until indicator rod extends approximately 1/2 inch from top surface of cap.

3. Insert needle into Alemite fitting until sufficient pressure is relieved to lower indicator the required amount 3/8 inch from top surface of cap.

4. Replace Alemite fitting cap and tighten securely.

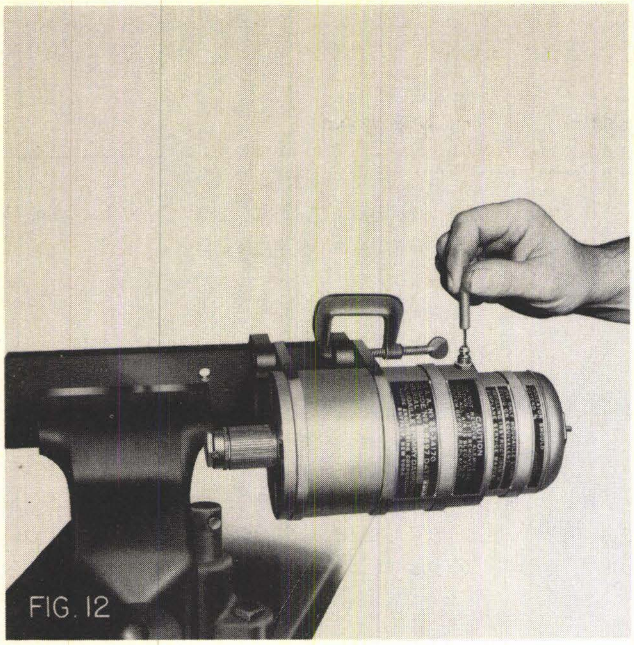

FIG. 12

To refill with oil:

1. Remove shimmy damper from nose gear strut.

2. Remove reservoir cap spring and diaphragm from top of damper.

3. Turn unit upside down, operate lever arm slowly until all fluids are pumped out of unit.

4. With unit right side up, fill reservoir with new fluid and operate lever arm slowly at full stroke until fluid is drawn into operating chamber and no air bubbles appear in the fluid.

CAUTION: Fluid level in reservoir must be maintained at height of 3/4 inch or more during this operation.

5. With fluid level still 3/4 inch or more, check to feel if there is any air in unit. This is done by operating a lever arm a full stroke for several times. The feel in the movement of arm should be solid. If a spongy or spring feeling is noticed, that indicates that air is in the chamber. Continue to bleed balance of air from unit by operating lever until movement feels solid.

6. Fill reservoir with fluid to a level 1/2 inch from top of unit and replace diaphragm, springs and cap, screwing it on until tightly sealed.

7. Turn unit on side with filler plug on top; insert needle into Alemite fitting until balance of air is bled out.

8. Fill damper through Alemite fitting until indicator rod extends approximately 1/2 inch from top surface of cap.

9. Insert needle into Alemite fitting until sufficient pressure is relieved to lower indicator the required amount. (3/8 inch from top surface of cap).

10. Replace Alemite fitting cap, tighten securely and safety in place.

If it is necessary to replace the lower packing "L", it is extremely important that the cover lock screw "R" be removed before the cover plate is removed. This screw is sealed in a low melting lead alloy. When the cover is replaced it must be tightened with at least 7200 inch pounds torque which is equivalent to 200# force on a

three foot wrench. There is a special shimmy damper repacking spanner wrench provided for this purpose. The lock screw must be replaced after tightening.

SHIMMY DAMPER TROUBLE SHOOTING

In case of slight shimmy the following items should be investigated for play or looseness in the shimmy damper connecting parts.

Shimmy Damper

1. Check fluid level.
2. Check for signs of leakage (small traces of leakage are not serious).
3. Check static position of nose shock strut. If strut is extended too far, release some of the air from the cylinder. This may be necessary when operating from fields at high altitude or where the temperatures are extremely high.

Torque Links

1. Disconnect torque links at outer end.
2. Check upper and lower link for side play and looseness at attaching bolts to strut.
3. Replace all worn bushings or bolts.
4. Check for broken parts.
5. Check for looseness in shimmy damper connecting link bolts.
6. Take up all play in bolts, but do not tighten enough to bind.

If shimmy persists exchange damper from a ship that is working satisfactory. If shimmy disappears with this exchange, replace with new damper.

If shimmy still persists, it may be caused by the wheels or brakes.

1. loose nose wheel
2. nose wheel tire under inflated
3. nose wheel out of balance
4. rough or sticking brakes,possible buckled brake plates
5. main wheel out of balance

MAIN AND NOSE GEAR DOORS, GENERAL

There are two sets of landing gear doors on the B-25 corresponding to the main and auxiliary landing gear, or nose wheel. As the landing gear is lowered or retracted these doors open allowing the gear to pass, then close again to maintain the contour of the airplane. This motion is achieved by a mechanism attached to the landing gear oleos and is operated by the motion of the landing gear itself.

NOSE WHEEL DOOR INSTALLATION

Considering first the nose wheel doors, (see Fig. 13): There is a unit made up of two doors which completely closes the nose wheel well when the gear is retracted. This unit consists of the main door and a small flap door which is hinged onto the main door at the lower front corner. This small flap door remains open while the gear is down, allowing the nose wheel oleo to protrude through the fuselage while the main door remains closed.

This small flap door is normally held in a "CLOSED" or neutral position against its stop, by spring tension. Its motion is accomplished by striking a cam, or rubbing strip on the oleo as the main door closes. There is practically no adjustment necessary on this door, it merely being necessary to locate the cam in the proper place on the oleo as called for on the drawings.

The large door is operated by a system of linkage and bellcranks connected to the landing gear trunnion. This mechanism is extremely critical and in order to obtain satisfactory operation of the doors it is imperative that the linkage be adjusted to the proper lengths. To obtain these lengths it is necessary to follow the procedure hereinafter outlined.

With the ship on the jacks,install and trim the doors (in case of new doors), to obtain the proper clearance all around. Remove the flap door from the main door. Install strut "A" connecting one end to the short arm of the bellcrank below the pilot's floor and the other end to the actuating arm on the aft side of the trunnion. The motion of the door is entirely governed by this link, and it must have exactly the proper length in order for the motion of the door to be split.

Next, connect link "B" to the long arm of the bellcrank and to the universal on the door opening fitting. Adjust the length of this strut so that with the gear in the down position and with the door opening fitting bolted, the inboard edge of the door drops about 1 inch below the fuselage. Slowly retract the gear and observe the clearance of the wheel on the door to make certain there is no interference. With the gear in the retracted position, check to see whether the door has returned to its original 1 inch position or not. If it is gapping open more than it was with the gear in the down position lower the gear and open the door by slightly retracting the gear. Disconnect one end of strut "A" and lengthen it by unscrewing the end fitting one or two turns. If, on the other hand, the door gaps open more with the gear in the down position, shorten the strut. Connect the strut and repeat the process until the door returns to the same position, with the gear in the retracted position, that it had in the down position. (In a few cases it was found necessary to shim the bottom of the actuating arm out from the trunnion by from 1/32 inch to 1/16 inch at the lower bolt to split this motion.) Actually the door should close tighter with the gear in the retracted position than in the extended position. This is accomplished when the motion is exactly split by slightly lengthening strut "A".

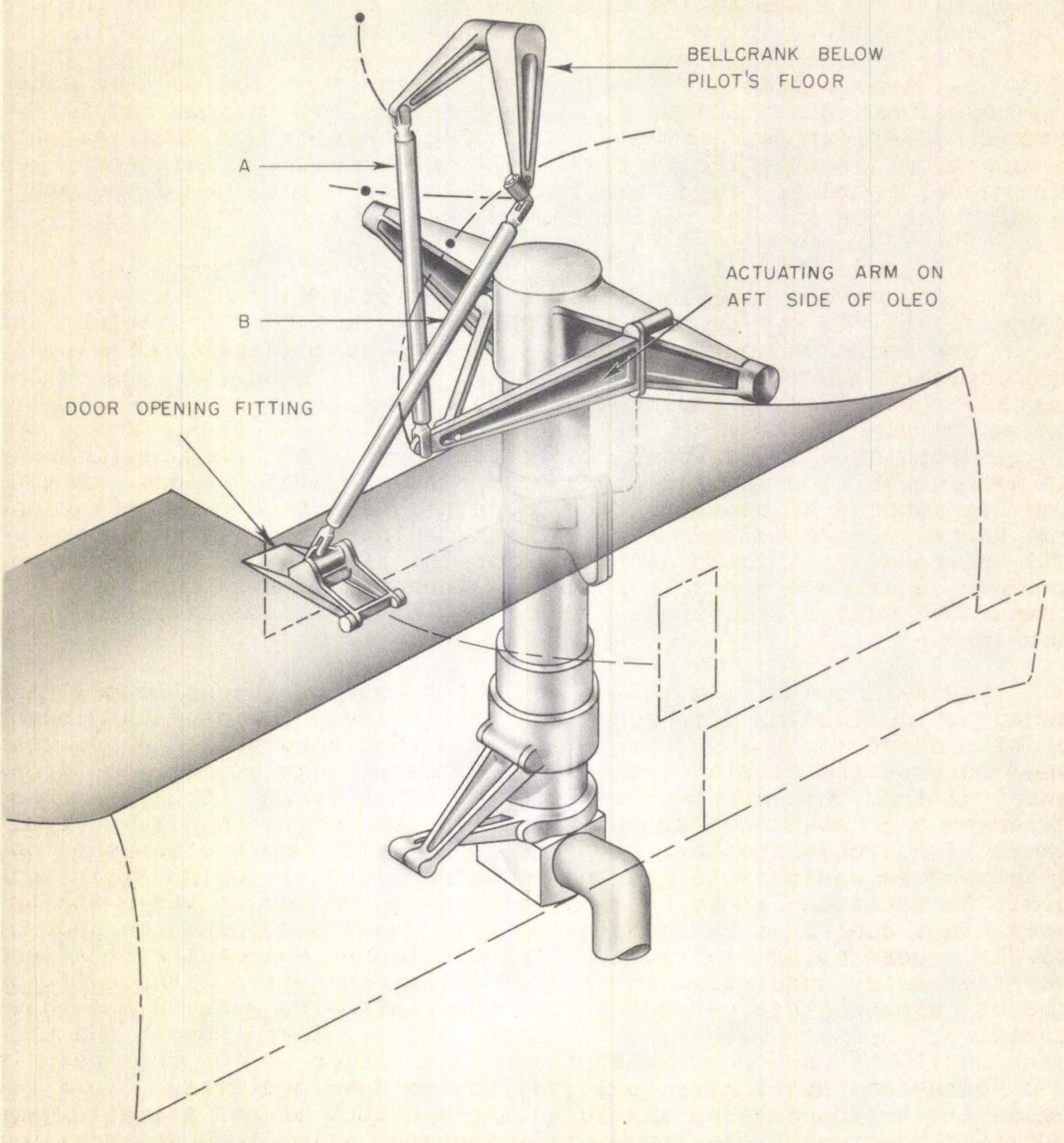

FIG. 13 NOSE-WHEEL DOOR OPERATING MECHANISM

After the motion has been satisfactorily split by the above procedure, open the door by partially retracting the gear and adjust the length of strut "B" to pull the door up tight against the door stops when the gear is in either the up or down position. The door can be assumed to be properly rigged when it requires a force of approximately 110 pounds applied to the inboard edge to gap it open with the gear in the retracted position and about 45 pounds to gap it open with the gear in the down position.

With the door thus properly rigged, retract the gear slightly from the down position, allowing the door to open and install the small flap on its inboard forward edge. It is then wise to observe the operation of this door as the gear is slowly brought to its fully extended position to check the proper alignment of the cam on the oleo. This completes the rigging of the nose wheel doors.

LANDING GEAR DOORS INSTALLATION

The main landing gear doors (see Fig. 14) consist of a small flap door and two large doors attached to the nacelle. The flap door on the main gear is located forward of the inboard main door and is actuated by a strut attached to the diagonal brace strut on the oleo and to a fitting on the forward edge of the flap door. When the gear is in the retracted position this door is closed. As the gear is lowered it opens, remaining open while the gear is in the down position, providing an opening in the nacelle for the oleo. This door must be trimmed and fitted to the nacelle at the same time the main doors are fitted. A rubbing angle on the aft end must be coordinated with a similar angle on the forward end of the inboard main door.

The main doors consist of an inboard and an outboard door attached to the landing gear oleo through a system of linkage and bellcranks. These doors operate with the gear, opening to allow the wheel to pass and closing again when the gear is in either the up or down position. They are supplied with an extra amount of skin around the edges and are to be trimmed and fitted to the nacelles. One, however, will have the keel line already trimmed and the other is to be trimmed on assembly to give the tolerances called for on the drawings. As mentioned above, the rubbing angle on the forward end of the inboard door must be coordinated with the one on the aft end of the flap door. There is from 1/8 inch to 1/4 inch twist built into these doors to insure the aft end's closing, the aft end coming into contact with the door stops before the forward end is completely closed.

After the doors have been properly trimmed and fitted, connect and adjust the linkage in the following manner. First install the torque tube assembly to the center section, as shown on the main landing gear installation drawing. Spacers are provided for shimming between this tube and the rear mounting fitting in order to properly locate the tube in the fore and aft direction. This is the only

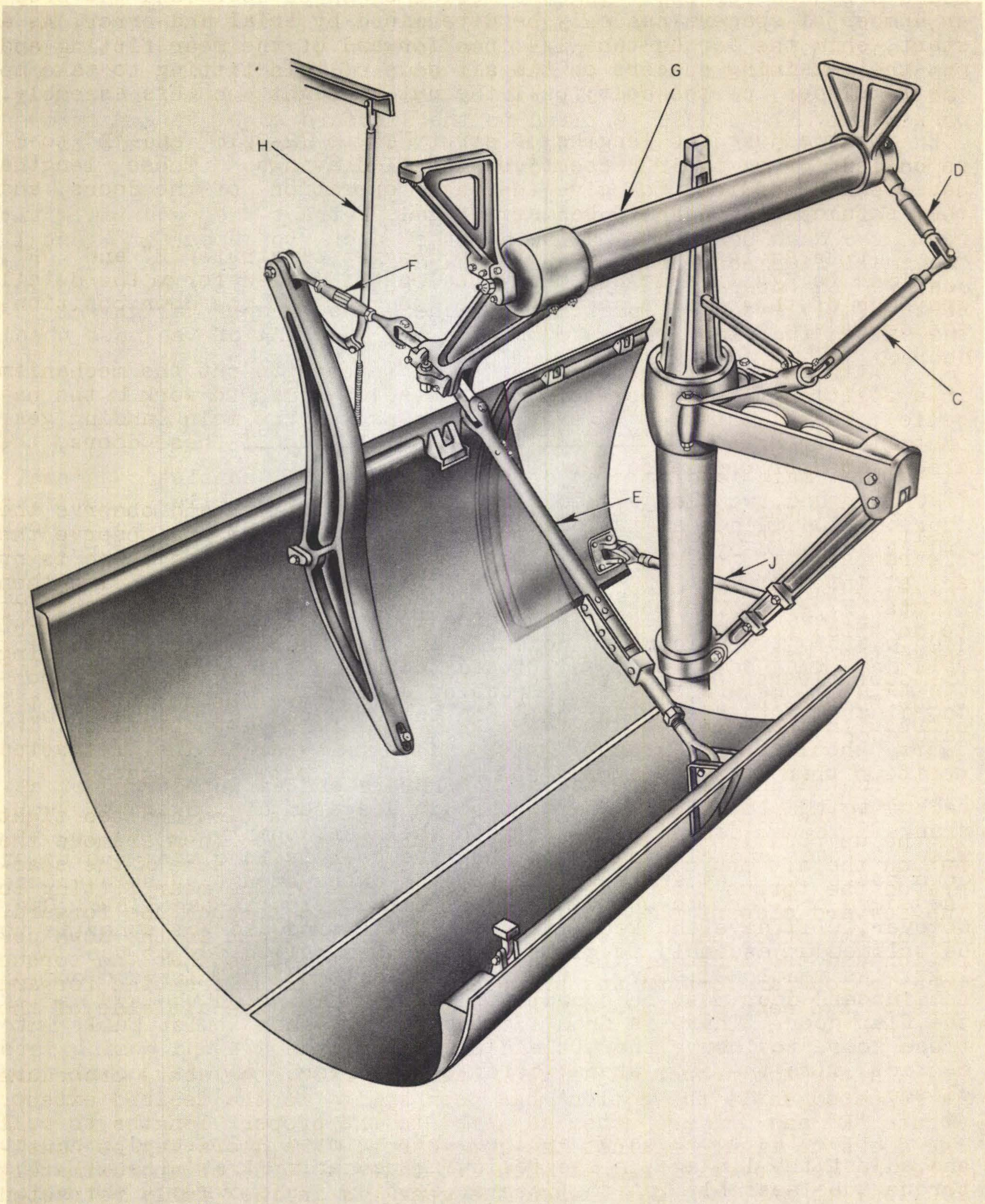

FIG. 14 MAIN GEAR DOOR OPERATING MECHANISM

means provided for splitting the motion of these doors, and the proper number of spacers can only be determined by trial and error. As a start, shim the torque tube 1/4 inch forward of the rear fitting and put the remaining spacers on the aft side of this fitting to take up the remainder of the bolt; pull the nut up tight on this assembly.

Next, adjust the lengths of strut "C" to 12-9/16" and "D" to 6" as called for on their respective detail drawings. These lengths have been determined to give the best operation of the doors, and they should never have to be varied.

It is advisable to adjust the lengths of struts "E" and "F", 1/2 inch to 3/4 inch longer than the lengths called for on the detail drawings of these parts so that with the gear in the down position, the doors are gapped open by about 1 inch.

With the gear slightly retracted (enough to put the mechanism in a position to gap the doors open to allow a man to work in the nacelle), install struts "E" and "F", as shown on the main landing gear installation drawing. To facilitate the rigging of these doors, the oleo flap door should be removed.

Lower the gear to the fully extended position and observe the position of the doors. Now, slowly retract the gear and observe the clearance of the gear on the doors, to make certain that there is no actual interference. If there should be an interference, lengthen struts "E" and "F" enough to eliminate it. If it becomes necessary to do this, return the gear to the extended position and again observe the position of the doors. Slowly retract the gear, checking the door clearance. If the gear clears the doors, allow it to continue to the fully retracted position and compare the position of the doors with that observed when the gear was in the down position. The doors should be slightly tighter with the gear in the retracted position than in the extended position, to be properly rigged.

If the doors are too loose in the down position and too tight in the up position, retract the gear enough to open them, remove the nut on the aft end of the torque shaft and transfer some of the spacers on the torque tube bolt from the aft side of the rear fitting to the forward side of the fitting. This moves the torque tube forward. If, on the other hand, the doors should be too tight in the down position and too loose in the up position, it indicates that the torque tube is too far forward and shims should be removed from the forward side of the rear fitting and added to those on the aft side of the fitting.

After the proper adjustment has been made, the above procedure is repeated until the motion has been split to the desired extent. Struts "E" and "F" are then adjusted to the proper lengths to pull the doors up tight against the door stops. The doors may be considered to be properly rigged when it takes a force of approximately 100 lbs. to gap them open when the gear is in the fully retracted position. In the extended position it is permissible to have the doors slightly gapping open, however, it is desirable to close them

to the extent that it will require approximately 45 lbs. to gap them open. Care should be observed not to rig the doors too tight with the gear in the extended position, as too much tension in the mechanism will prevent the gear from locking in the down position.

After the doors have been properly rigged, according to the above procedure, the "pre-loader" should be adjusted. This is a roller set screw assembled on the end of the actuating arm on the aft end of the torque tube. This roller should be adjusted to ride on the oleo strut when the gear is in the retracted position. It is intended to relieve the mechanism from the door loads and to prevent the doors from gapping open in flight due to deflection in the mechanism. It is not intended that this roller should take all the load and it should not be so adjusted. Satisfactory adjustment is to have it ride firmly on the oleo with the gear in the retracted position.

The retaining cable should now be attached to wing stringer No. 14 at the hole provided in the stringer, and to the link on the actuating arm on the aft end of the torque tube. The length of this cable should be adjusted so that with the doors in their maximum open position, it is approximately 1/8 inch too long and there is consequently no tension in it. This cable is provided merely to prevent wind-buffeting from causing the doors to swing beyond center when they open.

After the main doors have been properly rigged, the oleo flap door should be installed, and strut "J" set to the length called for on its drawing and installed per the main landing gear installation drawing with the gear in its extended position. There should be a minimum clearance of 1/4 inch between this strut and the oleo. If this clearance is shy, a washer of the necessary thickness should be placed under the shoulder of the eye-bolt on the fitting on the diagonal brace strut. When this strut has been satisfactorily installed to give the desired clearance on the oleo, the landing gear should be slowly retracted until this door is closed. The length of strut "J" should be varied as required to hold the door tightly closed with the gear in the fully retracted position.

The entire mechanism should be checked to see that all cotter pins and lockwires are installed as called for, and all bonding wires connected and all nuts tightly installed at the hinge fittings.

In order to gain access to the nacelle when the ship is on the ground,the inboard door is provided with a bolt accessible through a hole in the outer skin. By cutting the lockwire and removing this bolt, the inboard doors may be opened. The outboard door may be opened by removing the two No. 10 bolts through the ends of the link in strut "E" and allowing this link to rotate through approximately 160°. This process will relieve the tension in this strut and allow the bolt attaching it to the door to be removed.

The nose wheel door may be opened by cutting the lockwire on the bolt which is accessible through a hole in the outer skin, and removing this bolt. This will allow the door to gap open far enough to remove the bolt connecting the strut to the door opening fitting.

ADDENDUM I

Items peculiar to B-25, B-25A and B-25B Airplanes only.

1. SHIMMY DAMPER GENERAL

A hydraulic damper (see Fig.15) was developed to prevent shimmy which is inherent in all castering type wheels. The damper is attached securely to the front of the shock strut, and through the arm "A" and link "B" it connects to the upper torque link collar lug "C".

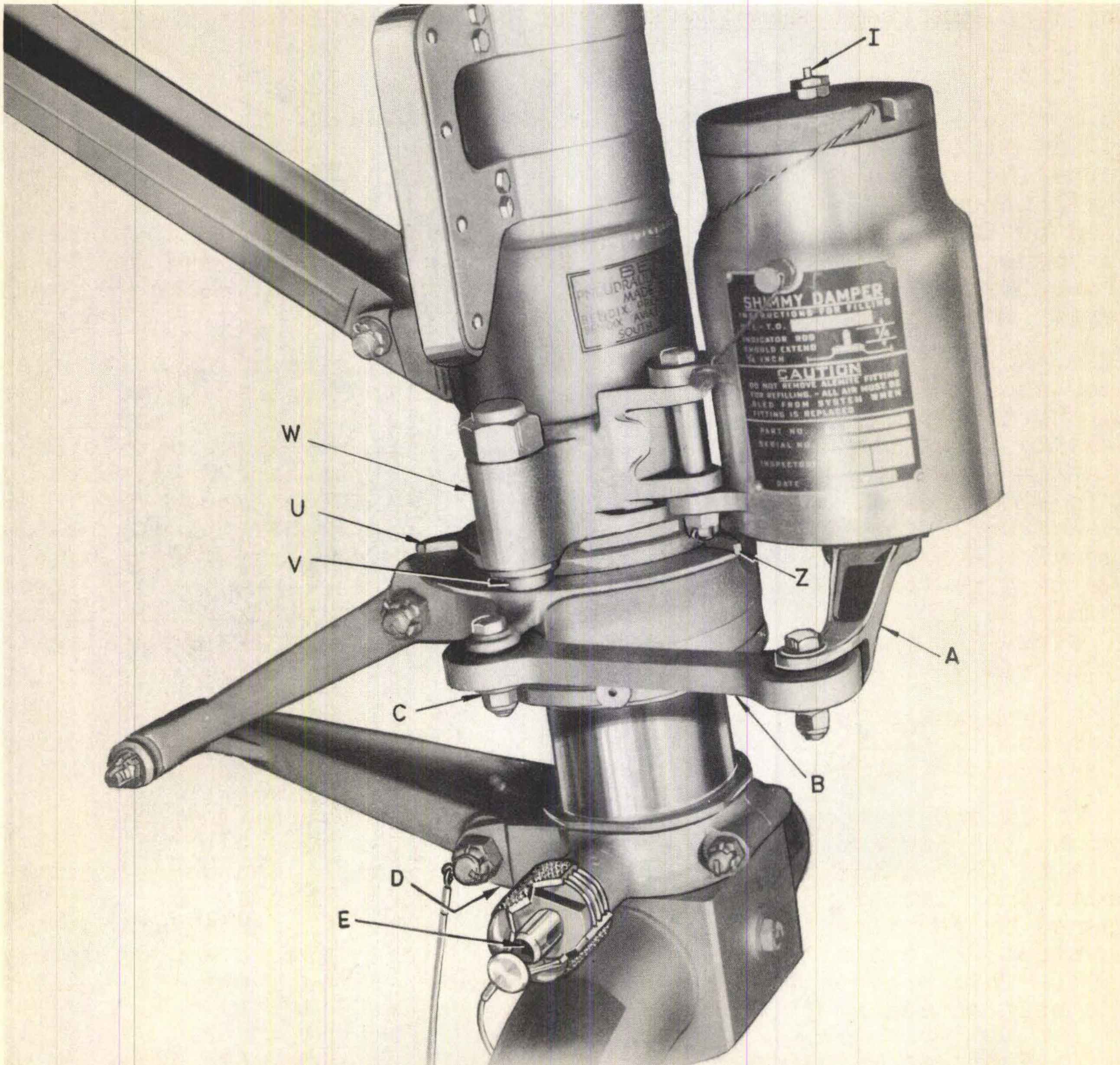

FIG. 15 SHIMMY DAMPER INSTALLATION (B-25, B-25A & B-25B)

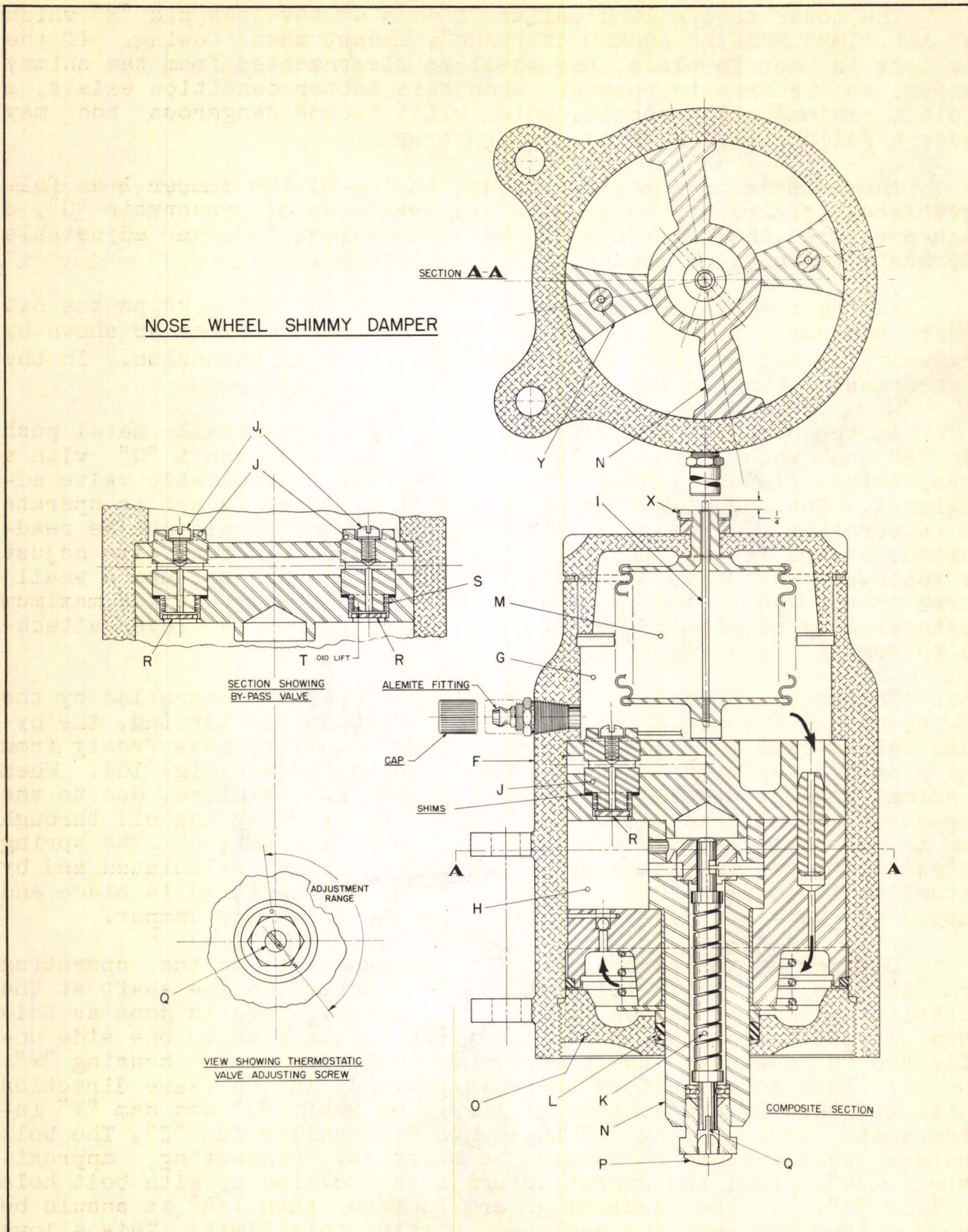

FIG. 16

SHIMMY DAMPER SECTIONAL VIEW
(B-25, B-25A AND B-25B)

The lower torque link collar "D" has a tow lock pin "E" which "AT ALL TIMES MUST BE LOCKED IN PLACE", except when towing. If the tow lock is not in place, the wheel is disconnected from the shimmy damper, and is free to rotate. When this latter condition exists, a violent shimmy will result, which will become dangerous and may cause a failure when taxying.

The internal mechanism and functioning of the damper is as follows (see Fig. 16). A housing "F" enclosing an oil reservoir "G", a high pressure chamber "H", two by-pass valves "J", an adjustable thermostatic valve "K" and the oil packing "L".

In the reservoir chamber is a bellows "M" which keeps the oil under pressure, forcing it in the high pressure chamber as shown by arrows. The bellows also compensate for thermal expansion. In the high pressure chamber the wing shaft "N" operates.

At the bottom of the wing shaft there is a small metal push cap "P" and when removed it exposes a 1/4 inch shaft "Q" with a screw driver slot (see Fig. 16). This is the thermostatic valve adjustment. The adjustment as it leaves the factory is set to operate in temperature ranging from -50°F to + 120°F and should not be readjusted, except in case the packing is replaced. In such case adjust as follows: Heat unit in water at +90°F for 1/2 hour, use a small screw driver and in the range shown on Fig. 16, set until a maximum resistance is obtained. To test resistance, use a 24" lever attached to arm "A" (see Fig. 12).

The actual operation of the shimmy damper is controlled by the by-passes and thermostatic valves. For taxying and turning, the by-pass valves come into action by allowing the oil to pass freely from one side of the wing shaft to the other side (see Fig. 16). When a shimmy attempts to set up, these by-pass valves close, due to the pressure against the valve disc "R", thus forcing the oil through the thermostatic valve which prevents the shimmy action. The spring "S" and lift "T" in the by-pass valve have been calculated and by actual test determined at our shop. They are safetied in place and should not be disturbed during the life of the shimmy damper.

Clamped on the serration of the wing shaft is the operating arm "A" (see Fig. 15). This arm must be located on the shaft at the installation of the damper to the shock strut. This is done as follows: First: unlock tow pin "E" and push torque link to one side until stop "U" contacts the boss "V" on centering lock housing "W". Second: Push shimmy damper operating arm "A" in the same direction until it stops by the contact of the wing shaft "N" and dam "Y" inside unit. Connect link "B" to torque link collar lug "C". The bolt centers on the link "B" should be short of connecting, approximately 1/4". Pull the operating arm back to line up with bolt hole in link "B". If the operating arm is more than 1/4" it should be removed from the unit and replaced within this limit. This allows the wing shaft to be pulled away from the dam slightly, and the stops "U" and "Z" act as stops instead of the wing shaft and dam. Check adjustment by moving torque links to other side and if correctly adjusted the stop "Z" will contact boss "V".

WARNING: It is important that stops "U" and "Z" contact instead of allowing wing shaft and dam to contact.

SHIMMY DAMPER SERVICE AND MAINTENANCE

There is not much to do in servicing the shimmy damper. The damper SHOULD NOT BE DISASSEMBLED. The most important thing to watch is the red indicator rod "I" (Fig. 16) at all times. If it extends above or below, it may be adjusted as follows:

To lower indicator rod:

1. Remove cap from Alemite fitting on side of shimmy damper, insert needle in Alemite fitting and hold until sufficient pressure is relieved to lower indicator rod the required amount.

2. Replace Alemite fitting cap, tighten securely, and safety with lockwire.

To raise indicator rod:

1. Thoroughly clean an ordinary hand-operated Alemite grease gun and fill gun with No. 475 Houdaille Fluid. This fluid may be purchased from Houde Engineering Corp., Buffalo, New York.

2. Fill damper through Alemite fitting until indicator rod extends approximately 3/8 inch from nut.

3. Insert Needle into Alemite fitting until sufficient pressure is relieved to lower indicator the required amount (1/4 inch from hex nut).

4. Replace Alemite fitting cap and tighten securely.

Inspect for oil leaks around wing shaft where it extends through lower cap. If there is evidence of leakage replace packing.

To Replace Packing: The procedure outlined below should be followed:

1. Mount unit on suitable jig with wing shaft up.

2. Release pressure from unit by inserting needle into Alemite fitting.

3. Remove operating arm "A".

4. Remove nut "O" using wrench 62-73016.

5. Replace packing.

6. Replace nut "O" and screw down tightly with wrench 62-73016.

A load of approximately 200 lbs. should be applied at the end of this wrench in order to seat the dam securely in place. This precaution is necessary as the pressure built up inside the unit tends to separate the dam and valve plate. Safety the nut in place with lockwire.

To refill with oil:

1. Remove shimmy damper from nose gear strut.

2. Remove reservoir cap and bellows from top of damper in one unit, using special wrench, Dwg. No. 62-73015, provided for this purpose. Removal of the reservoir cap and bellows does not require the removal of the hex nut through which indicator rod protrudes.

3. Remove fillister head screws J from valves located in bottom of reservoir; turn unit upside down, operate lever arm slowly until all fluid is pumped out of unit.

4. With unit right side up, fill reservoir with new fluid and operate lever arm slowly at full stroke until fluid is drawn into operating chamber and no air bubbles appear in the fluid.

CAUTION: Fluid level in reservoir must be maintained at height of 3/4 inch or more during this operation.

5. With fluid level still 3/4 inch or more in reservoir, replace fillister head screws. At this point check to feel if there is any air in unit. This is done by operating a lever arm a full stroke for several times. The feel in the movement of arm should be solid. If a spongy or spring feeling is noticed, that indicates that air is in the chamber. Remove fillister head screws and continue to bleed balance of air from unit.

6. Fill reservoir with fluid to a level 1/2 inch from top of unit and replace cap, screwing it on until tightly sealed.

7. Turn unit on side with filler plug on top; insert needle into Alemite fitting until balance of air is bled out.

8. Fill damper through Alemite fitting until indicator rod extends approximately 3/8 inch from nut.

9. Insert needle into Alemite fitting until sufficient pressure is relieved to lower indicator the required amount (1/4 inch from top of hex nut).

10. Replace Alemite fitting cap, tighten securely and safety in place.

TAIL SKID MAINTENANCE

On B-25, B-25A and B-25B airplanes the tail skid shock strut operated concurrently with the main landing gear and auxiliary nose gear.

With tail skid shock abosrber strut fully extended, fill with fluid conforming to A. C. Spec. 3580 as per T. O. 06-1-2. Inspect tail skid shock strut daily for proper air pressure by manually pushing up on tail skid. If tail skid feels soft and does not return readily to the extended position, check for cause of loss of pressure and inflate shock absorber strut to a pressure of 30 lb./sq.in. When shock strut has been removed for servicing, always hold strut cylinder in a vertical position when filling with fluid. WARNING: Whenever the emergency pneumatic brake system has been used, it is necessary to thoroughly bleed the brake hydraulic system. Use air pressure brake system in an emergency only.

HYDRAULIC
INSTALLATION

NORTH AMERICAN AVIATION Inc.

Hydraulic Install. LECTURE

B-25 SERIES AIRPLANES

PREPARED BY *Howard Field. Jr.*

NOTE

THE INFORMATION CONTAINED IN THIS LECTURE WAS CORRECT AS OF MAY 15, 1942. REFER TO HANDBOOK OF OPERATION AND SERVICE INSTRUCTIONS FOR THE LATEST INFORMATION.

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INGLEWOOD, CALIFORNIA

INDEX

ILLUSTRATIONS

ILLUSTRATIONS (Cont.)

PART I

A Hydraulic System may be defined as a system for transmitting power by means of fluid under pressure.

There are, of course, many ways other than hydraulic of transmitting power from one place to another; such as electrical, in a very wide selection of ways (for example - an electrical generator connected by wires to a motor, or a battery connected to a solenoid, etc.). Another means is by developing heat, carrying it through pipes, and then transforming it to work by means of an engine. We may also accomplish the same result by purely mechanical means such as shafts and gears or belts or push-pull rods, etc. All systems have their advantages and disadvantages, and the choice of which to use depends almost entirely upon circumstances. Any one system would be ridiculous in some places and the best way in other places.

Hydraulic systems,like other kinds of systems, have advantages and disadvantages, but for some uses on an airplane their advantages are so great that we are forced to accept their disadvantages. Primarily our reasons for using them are five in number: -

1. They are a relatively efficient means of delivering work where we want it and when we want it.

2. They are susceptible of extremely fine control.

3. They are very versatile.

4. The individual operating units are simple.

5. The weight of the moving parts and of the systems as a whole is very small.

It is obvious, that in order to accomplish any transmittal of power by means of a hydraulic system, we must have: -

1. Some means of putting the energy into the fluid (in other words - a pump).

2. Some way of confining the fluid and directing it to the place we want the work done (pipes or lines).

3. Some means (such as cylinder or other kind of fluid motor), of transforming the energy we have put into the oil back into useful work.

For practical purposes we find that we need more than just those three essentials. Even so simple a system as an automobile brake has a reservoir to hold fluid for making up losses, and some means of allowing the fluid in the brakes and lines to flow back to the reservoir if the fluid should expand due to heat.Most systems are much more complicated and it is up to the service mechanic to keep them working properly so that they will continue to do what is intended. If

we could be sure that nothing would ever go wrong, or wear out, or leak, or no bullets would come too near, there would be no necessity for the man entrusted with the maintenance to know anything more than where to look to see if there were enough oil. Unfortunately we have not reached that place, so the mechanic still has plenty to do and, we believe, he will find his work greatly simplified if he knows something about WHY as well as HOW the system functions. A very quick and much simplified review of a few of the most useful parts of the study of Fluid Mechanics may help in understanding the WHY.

Let us start with a simplified definition of fluid. A fluid is a form of matter which takes its shape from its container. Either a liquid or a gas is a fluid and, strangely enough, they both obey the same laws. The chief difference is that a gas is easily compressible while a liquid can only be compressed slightly under tremendous forces and, for all practical purposes, may be considered as not compressible at all. In a hydraulic system we are interested mostly in liquids although gases are used in some parts of the system and will be taken up when we come to them.

We are interested in transferring energy, so let's see a little about the laws that govern that process. There are several forms of energy and one of the most important natural laws of which we know relates to these several forms of energy. It is called the "Law of the Conservation of Energy", and it says that "Energy may be changed from one form to another but can neither be created nor destroyed." Sometimes we convert energy into a form our machines are not at the moment adapted to reconvert into a useful form. One glaring example of this is what we call friction. This is really a conversion of mechanical energy into heat energy and we wouldn't object to it if only it would happen under a boiler where we could make use of it.

The particular law which governs the conversion of energy from one form to another in a hydraulic system is known as Bernoulli's Law in honor of the Italian who did so much to advance the world's knowledge of hydraulics. The forms of energy this law deals with are:

1. Potential energy due to position.

2. Potential energy due to pressure (usually called simply Pressure Energy).

3. Kinetic energy which is due to velocity.

Now, Bernoulli's law says that for an ideal fluid the sum of the potential energy plus the pressure energy plus the kinetic energy at any section of a fluid stream is equal to the same at any other section of the same stream. In the language of mathematics this looks like -

$$h_1 + \frac{P_1}{W} + \frac{V_1^2}{2g} = h_2 + \frac{P_2}{W} + \frac{V_2^2}{2g}$$

This is exactly true for an "Ideal Fluid" (one in which there is not friction) but, unfortunately, we are not able to find any such thing and all the fluids we know about have friction; so we have to add a term to one side of the equation to take care of this loss which we call "Lost Head". Another thing to consider, is that, for an airplane of ordinary size, the potential head is of no importance since the maximum pressure due to height is seldom more than a couple of pounds per square inch and we ordinarily have about 1000 lb. per sq. in.

Taking both these things into account our equation becomes -

$$\frac{P_1}{W} + \frac{V_1^2}{2g} = \frac{P_2}{W} + \frac{V_2^2}{2g} + h_L$$

This equation is very useful for the hydraulic engineer and an understanding of it may help the mechanic, particularly in "trouble shooting".

Let's try to see how this works and what it may tell us about our system in a couple of cases.

Let us suppose that there is pressure in the system but that all the cylinders have reached the end of their strokes, etc., so that there is no flow of fluid. It is evident that V will be 0 and consequently $V^2/2g$ will be 0. Also, h_L will be 0 because without motion there can be no frictional loss. Then all we have left of our equation is -

$$\frac{P_1}{W} = \frac{P_2}{W}$$

which is the mathematical statement of one of the most important laws that govern fluids. It means that so long as we have no flow we have the same unit pressure against all surfaces of the container of any continuous body of fluid. It makes no difference what the shape of the container is - it may be ever so complicated - but so long as the fluid is continuous and there is no flow the pressure is the same on every square inch of the container and there is no loss.

Now that we see the conditions when there is no flow, let's try another condition. Let us, this time, assume that there is flow and that we have mythical "Ideal Fluid" which has no friction. Suppose we want to know what happens when our fluid flows past a place where the tube, which contains the fluid enlarges to four times its original area. In diagrammatic form it would be something like sketch shown in Fig. 1:

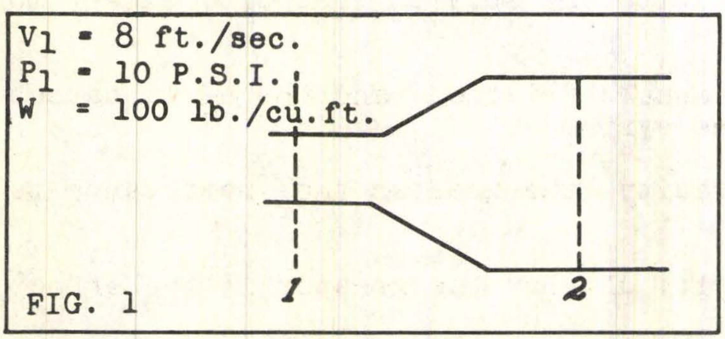


FIG. 1

It is obvious that during any one period of time the same amount of fluid must pass both Section 1 and Section 2. Therefore, the velocity at Section 2 can be only 1/4 of that at Section 1. Now let us substitute the values from the figure in our equation, remembering that we must use a consistent set of dimensions.

$$\frac{10 \times 144}{100} + \frac{8^2}{64} = \frac{P_2}{100} + \frac{2^2}{64}$$

$$\text{or } P_2 = 100\,(14.4 + 1.000 - .015) = 1538.5 \text{ lbs./sq. ft.} = 10.69 \text{ lbs./sq. in.}$$

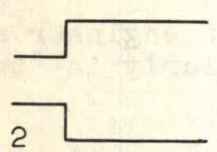


FIG. 2

This says that the pressure is actually higher than it was to begin with, and we would find by measurement that it is. It would make no difference whether the change in area of the tube were gradual as shown in Fig. 1 or very abrupt as shown in Fig. 2:

Remember that we were considering an ideal fluid. For any real fluid there would be a difference. We would find by measurement that the pressure downstream from the abrupt change was a little lower than downstream from the gradual change. The energy represented by this difference in pressure has gone somewhere and that somewhere is into heat. This heat came from internal friction in the fluid which brings up the question "Do all fluids have the same amount of internal friction?" The answer is "No". All real fluids have a property known as Viscosity. You might think of this as "heaviness" in the way that SAE 120 engine oil is heavier than SAE 30 oil. It actually is a property which depends on the resistance of a fluid to having its particles moved past each other (shear resistance) and also on the rate the shearing or internal movement takes place. That it depends on the rate of shear is evident if you will remember that it requires almost no force to pull a spoon out of a can of molasses (a very viscous fluid) if one pulls slowly, but if one pulls quickly he may pick up the whole can. The viscosity of any oil changes with temperature - becoming greater as the temperature is reduced. For AC Spec. 3580 oil, which is what we use almost exclusively in power operated hydraulic systems, the viscosity is about 2000 S. S. U. at 0 degrees F. and about 200 S. S. U. at 70 degrees F. We will go no further with the subject viscosity except to point out its effects.

1. It corresponds to internal friction and the h_L it causes appears as heat in the system.

2. The greater the viscosity the greater the resistance to flow.

3. The higher the velocity of flow the greater is the effect of viscosity.

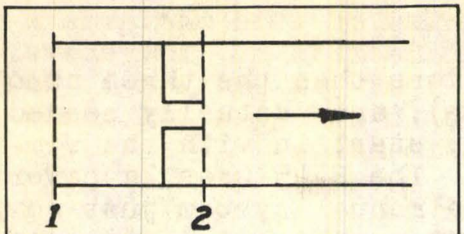


FIG. 3

There is just one more hydraulic phenomenon which we wish to consider before we start on hydraulic systems and their details. We often use an orifice to reduce the flow in a line when we want to make some part move slowly (viz. cowl flaps). An orifice is simply a small hole in a plate which otherwise would completely block off a tube (Fig. 3).

Let's write our pet Bernoulli equation for this case. Assuming that "V" at section 1 is so very small it is negligible.

$$\frac{P_1}{W} + 0 = \frac{P_2}{W} + \frac{V_2^2}{2g} \quad \text{OR} \quad V_2^2 = 2g\left(\frac{P_1}{W} - \frac{P_2}{W}\right)$$

$$\text{LET } \frac{P_1}{W} - \frac{P_2}{W} = H$$

$$\text{THEN } V_2 = \sqrt{2gh}$$

Now we have the velocity at Section 2 and if we remember that the quantity of fluid discharged in a unit time (Q) is obviously equal to the velocity of the stream times its area, we get -

$$Q = V_2 \times A = A\sqrt{2gh}$$

Ordinarily, we have a definite supply pressure, a definite pressure required for operation, and from them we find a definite pressure available to maintain flow through the orifice. We also have a definite area "A", after the part is made, so the rate of flow "Q" is definite and, consequently, the time of operation is fixed. Notice that this head "h" is that required to force the oil through the orifice and it is not dependent upon viscosity or friction. If one goes into the detailed theory of flow through an orifice he will find this is not absolutely true, but for any case we might have in an airplane hydraulic system, the difference is so very minute (say not more than one part in 1000) that it is always neglected. We point out this independence of the flow through an orifice from viscosity for this reason: - If we have some part such as cowl flaps which we want to have move in say 5 sec., we might use a very small line and no orifice. Then when the temperature dropped 70 degrees F. the time of operation might be nearly a minute because the resistance to flow in the lines would be so great due to higher viscosity. If, instead of using a small line, we use a larger one and limit the flow by means of an orifice, the line loss may increase only moderately and the orifice will remain constant; hence the time might be 10 sec. If the line were made large enough there would be no appreciable change in time of operation no matter what the thermometer did.

PART II

We said in Part I of these notes that more than the three absolute necessities, (pump, lines, and cylinder), are actually needed for any real hydraulic system. Let us, then, start in with the simplest system and find out what is required. The B-25 uses a power operated system so we won't waste time with a manual system just now, but will show later how the hand operated system, which is used only for emergency conditions, ties in with the power system.

In Fig. 4 we see just about the simplest practical power system imaginable. It consists only of a reservoir, R; an engine-driven pump, P; an operating cylinder,C; and since some control of the cylinder is necessary, a valve, V. The valve shown is a simple 4-way plug cock whose sole advantage is simplicity for diagrammatic purposes. Any hydraulic engineer who would use one on an airplane in this day of high pressures should have his head examined, but most of us like them on diagrams because they are so easy to draw and so easy to "follow through". Starting with the reservoir, which we assume to have sufficient oil in it, we find that the fluid flows out of the lower pipe and to the suction side of the pump, P. In the pump it has pressure energy and velocity energy put into it and then it goes out into the line connecting to the valve. Now, if the valve is turned so that the ports are as shown by the solid lines, the fluid will flow into the valve at the upper left, out at the upper right, and thence down into the right end of the cylinder. Here the fluid gives up part (the most part) of its energy into moving the piston to the left, thus using the piston as a mechanical means of transforming the energy into work - such as raising a landing gear which then stores the energy in potential form. Now, if this cylinder was full of oil,as it should be in any self-respecting hydraulic system, that on the left side of the piston must go somewhere. It is easy to see that it simply flows out through the line, into the lower left and out the lower right ports of the valve, and then to the reservoir. If the valve were turned so that the ports were as shown by dotted lines, the action would have been similar except that the piston would have moved to the right. We said that possibly this cylinder was connected to the landing gear retraction mechanism. If so, it would be likely that two cylinders would be necessary instead of just the one. The second cylinder would be connected into the system as shown by the dotted lines below the first cylinder. This type of connection is known as a "parallel connection" because the fluid divides and flows through two parallel circuits. Remember that we found that when there was no flow of fluid, the pressure was the same throughout the system? The opposite is also true - when the pressure is uniform throughout the system there will be no flow, and to go one step further, when the pressure is not uniform there will be a flow. All forms of energy tend to come to a common level, so energy at a high potential tends to fall, giving up part of its potential to energy at a lower potential, thus equalizing them. Getting back to our two cylinders in parallel, which are connected to the two landing gears, we see that if one gear has less air load, or less weight or less friction than the other, the fluid will flow so as to equalize the pressures and move the easiest one first. That is the reason that we so often see one wheel retract before the other

one. There are other ways to connect two cylinders so that this effect will not occur, but the other types of connection have so many disadvantages that we do not use them if we can avoid it.

We usually have such things as wing flaps, cowl flaps, or bomb doors which also have to be operated hydraulically, so we just connect them as shown by the dotted lines to the right of Figure 4. If we operate only one valve at a time, there will be no interference between the separate systems and all is well. Unfortunately, the pilot does not always cooperate 100% and we may, in practice, have two or more units trying to operate at the same time. Suppose, for example that the pilot has started to put the wing flaps down preparatory to landing and then before returning the valve to "neutral" he extends the landing gear. The wing flaps require about 600 pounds per square inch and the landing gear practically falls by itself. Then the fluid at the higher potential (600 psi) rushes out of the flap cylinder and into the landing gear cylinder. So far as the landing gear is concerned, that is O.K., but from the viewpoint of the pilot, it is anything but pleasant because the flaps retract and if he happens to be going too slow, the bottom falls out and the ground may come up and grab him. We cannot have that happen, so we have to do something about it.

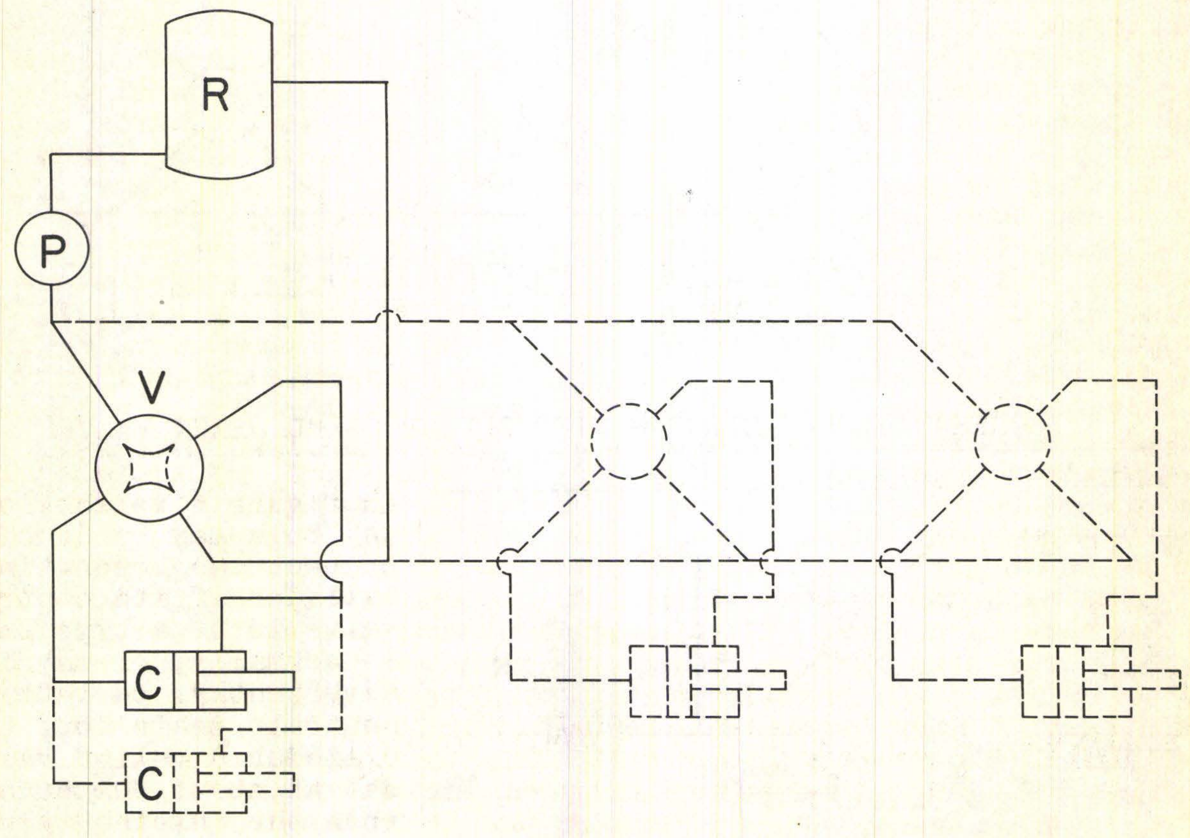


FIG. 4 SCHEMATIC DIAGRAM OF SIMPLE POWER SYSTEM

Obviously, it would be foolish to have a separate, complete hydraulic system for each operation, so we arrange things as shown in Figure 5. This shows the pressure line from the pump coming across the top from the left and feeding into the selector valves, but now each separate selector is fed through a check valve. This effectively prevents the fluid flowing out of one system when another at lower potential is connected to the pressure line. We cannot put the check valves in the cylinder lines because at different times they must carry fluid in either direction, but this is not true of the pressure supply from the pumps. When the temperature of hydraulic fluid rises it expands, and in so doing causes us lots of bother. The rate of expansion is about 4 to 5% per 100 degrees F. which is vastly more than the expansion of the system in which the fluid is contained. We must provide a way for the excess fluid to return to the reservoir before it would build up higher pressure than the system can stand.

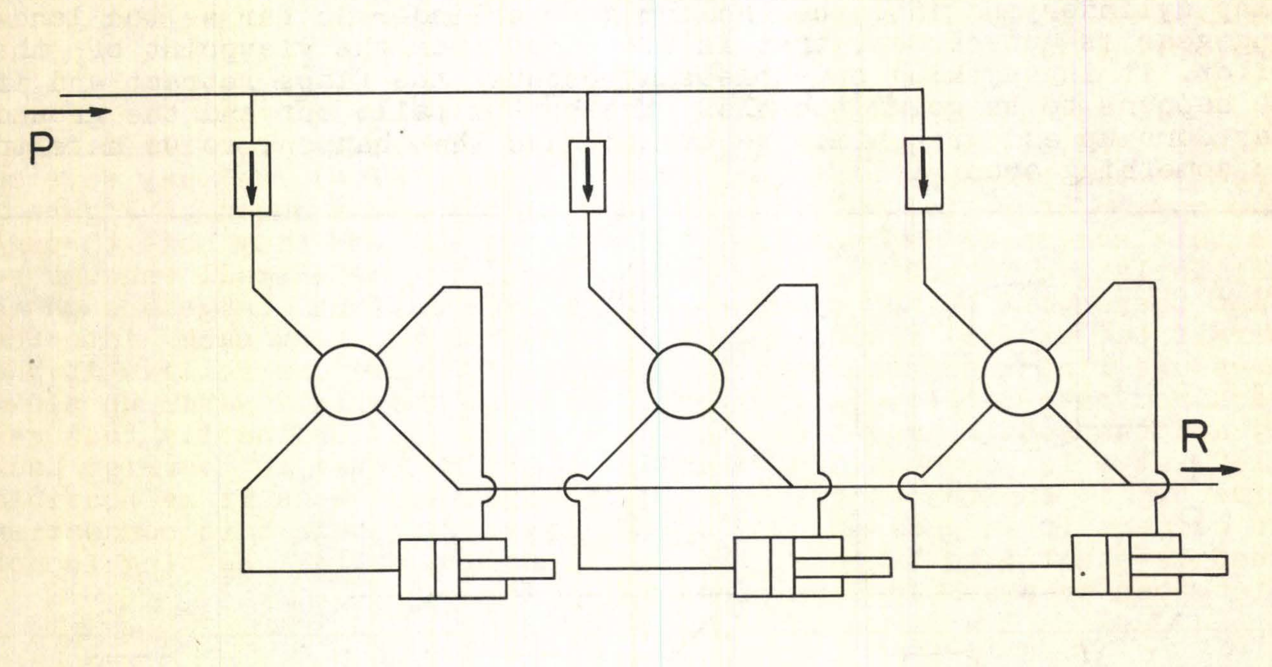


FIG. 5 SCHEMATIC FLOW DIAGRAM WITH SELECTOR AND CHECK VALVES

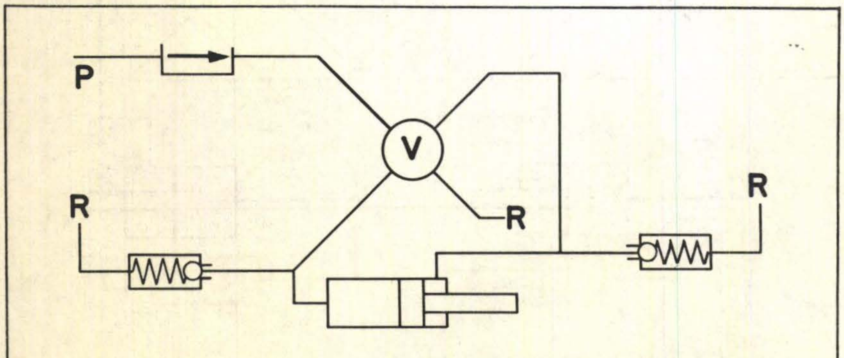


FIG. 6 SCHEMATIC FLOW DIAGRAM WITH SELECTOR, CHECK AND RELIEF VALVES

In figure 6 we show one way this may be done to protect an operating cylinder if its control valve is of a type that is normally, or may inadvertently, be left in neutral seals off the cylinder. A relief valve set at about 30% higher than the system pressure must be put in each line because both contain trapped oil.

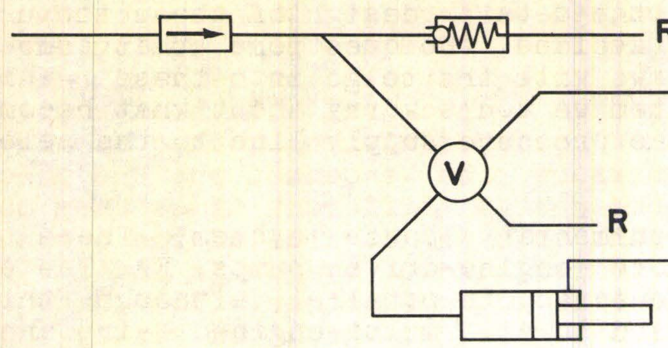


FIG.7 SCHEMATIC FLOW DIAGRAM WITH SELECTOR, CHECK AND RELIEF VALVES

If the valve had no neutral position it would be possible to protect the whole cylinder by means of only one relief valve which would be placed in the pressure line between the valve and the check valve. This is shown in Figure 7. The whole cylinder is protected because with this type of valve one end of the cylinder is always connected to the return, while the other is connected to the pressure and, consequently to the relief valve.

If we have several valves of this "no neutral" type, or if our valves are of a type which would allow pressure to bleed back through the pressure port (such as a poppet valve), we may save on the number of relief valves necessary by the means shown on Figure 8. In this scheme we use what is, in effect, a very tiny hole through the isolating check valves. This "leak" is made small enough so that there will be no adverse effects from it, but large enough to permit the excess fluid, due to expansion, to flow back into the pressure line where one good thermal relief valve can relieve it.The required rate of flow is very small because the fluid warms up slowly and the total amount of expansion is small. Ordinarily this relief valve is connected so that the fluid relieved is carried back directly to the reservoir, but in some special cases it is possible to connect it as shown by the dotted lines, although this connection must be studied to be sure that the pressure relief setting is not disturbed by possible back pressure.

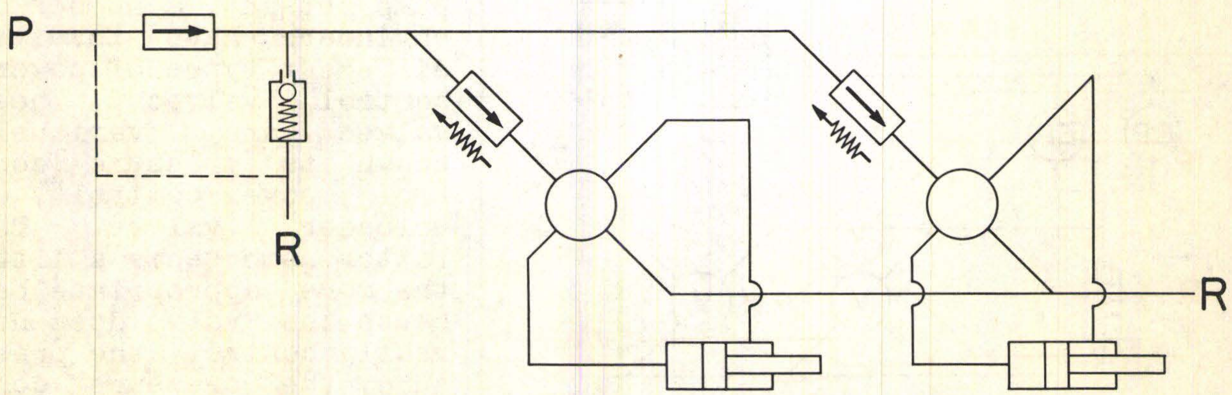


FIG. 8 SCHEMATIC FLOW DIAGRAM WITH SELECTOR, CHECK, RELIEF AND RESTRICTOR VALVES

That covers the distribution system in principle and we will leave it there until we come to the detail design of the units used in the B-25. We have, so far, avoided the questions that come up about the power system but now we will try to go into those. While we are going into the power system we won't worry about what becomes of the oil after it gets into the pressure supply line to the selector valves.

In Figure 9 we show a rudimentary power system. There is a reservoir, R, and one or more engine-driven pumps, EP. The engine pumps in the B-25 are connected in parallel, although this is not the type of connection used in all multi-engined airplanes. The pumps run all the time that the engines are going and consequently, pump fluid all the time. The fluid is not being used to operate some unit all the time, so we have large amounts of fluid pumped and nowhere for it to go. In order to keep the pressure from increasing beyond that desired, it would seem to be in order to provide a relief valve to allow it to return to the reservoir. This is shown. If we consider the conditions in the line between the pumps and the relief valve (when no unit is operating), we find we have a definite rate of flow and high pressure. Now in the line between the relief valve and the reservoir, we have the same rate of flow and very low pressure. In other words, the energy in the oil is large before the relief valve and small after it. There has been an apparent loss of energy, which we know must have gone into heat. If there is not too much heat it probably will not cause us any great difficulty because there is considerable radiating surface on the reservoir and lines. The limit seems to be in the neighborhood of 1/5 horsepower for heat loss in an ordinary sized airplane. On the B-25 there is about 4 horsepower constantly being put into the oil and if we dissipated all that in heat, the oil would boil very quickly and we would be in trouble. It is evident then that a relief valve will not do for regular use. Faced with the necessity of finding some other way to control the pump out-put, a number of engineers have invented different types of power-control valves. These valves are variously known as "pressure control", "power control", or "unloader" valves. The latter name seems a little the more appropriate because the valve does not really control the pressure, the pressure controls it, and its function is to unload the pump so long as the system pressure is high enough.

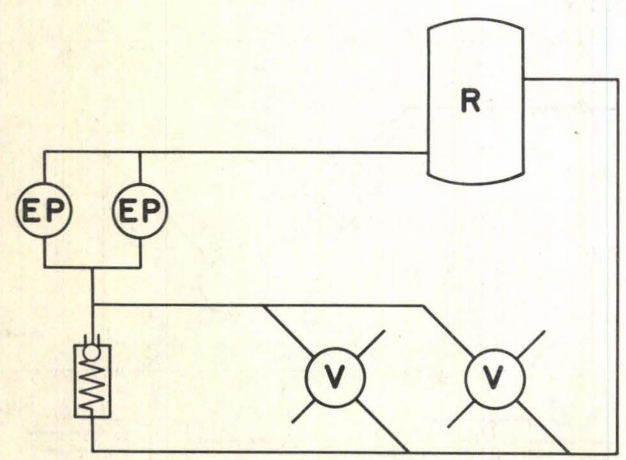


FIG. 9 SCHEMATIC DIAGRAM OF RUDIMENTARY POWER SYSTEM

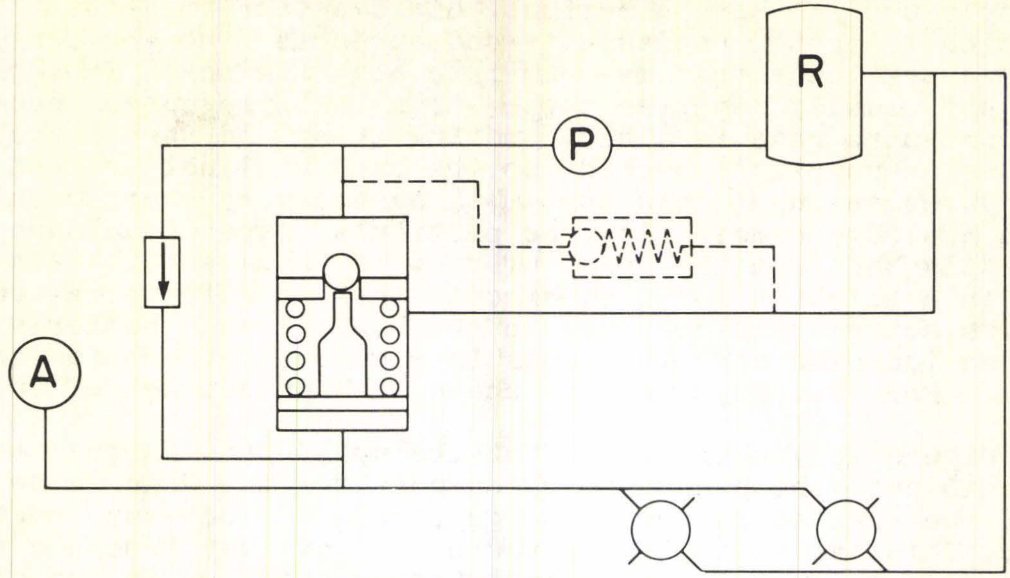


FIG. 10 SCHEMATIC DIAGRAM OF RUDIMENTARY POWER SYSTEM WITH UNLOADER VALVE

In Figure 10 we have shown one type of unloader connected into the power system. This is not the type used in the B-25, but it performs the same function and is a little easier to understand. The type used will be explained when we come to the detail parts in the B-25 system. The type consists of a housing having a wall across it near one end. In this wall is a hole upon which a ball seats. Below the ball seat is a plunger which can lift the ball from the seat when pushed up by a large piston at its lower end. The piston and plunger are held away from the ball by a large spring. Pressure from the system is put upon the top of the ball and the bottom of the plunger, and a return connection is made below the ball but above the piston. It works like this. The pressure holding the ball down plus the pressure from the spring tend to keep the piston down while the pressure against the bottom of the piston tends to raise it. When the pressure gets great enough so that the piston overcomes the force on the ball plus the spring the ball is raised off from its seat and the pressure from the pump is then by-passed to the return to the reservoir. Of course, the force tending to hold the ball down has now disappeared so that the piston kicks the valve wide open. When the pressure below the piston falls enough so that the spring can overcome it, the ball reseats. In Figure 10 we see the unloader valve by-passed by a check valve which is necessary to permit the pressure from the pump to get below the piston when the pump is putting out pressure and to prevent the fluid from returning when the pump is unloaded. No type of unloader valve can be made to work without having some sort of pressure accumulation in the system; because, if there were none, the valve would open only enough so that the pressure on both sides were in balance and there the valve would stay. A pressure relief valve is usually connected across the unloader valve as shown in dotted lines so that in case the unloader sticks or acts too slowly the pressure will not rise to a dangerous level. The system as shown in Figure 10 is the usual one for a

power supply but it has a serious disadvantage in that it pounds badly, which is both unpleasant and subjects the whole hydraulic set-up to shock loads that may run into high figures. The pressure gages do not usually register these transient pressures because an ordinary pressure gage is a slow moving thing and when installed in an airplane is usually "snubbed" so the hand will not vibrate. The pressure waves set up by this sort of thing are very short in duration, but so is a sledge hammer blow. The particular type of unloader shown is inherently bad from the point of view of these shock loads but by using it in a slightly modified circuit the bad effects may be minimized. The actual unloader used in the B-25 is much better and when used in the improved circuit shown in Figure 11, there is very little shock. For clarity we have shown the poor type of unloader.

In Figure 11 you will see that the upper part is just the same as Figure 10 but the pressure which goes to the under side of the piston of the unloader now must go through a one-way restrictor valve RC. This valve permits pressure to flow away from the unloader and the accumulator without restriction but flow in the opposite direction is restricted so that the pressure in the accumulator builds up slowly and the unloader, consequently, is slow to act. This prevents rapid loading and unloading and cuts down the hammering on the system. Since the valve will no longer unload quickly, the excessive fluid will by-pass through the relief valve PR. This makes the relief valve work more frequently but it does smooth out the operation, and the slightly higher relief valve pressure, being smooth, does less harm than a shock from a slightly lower pressure.

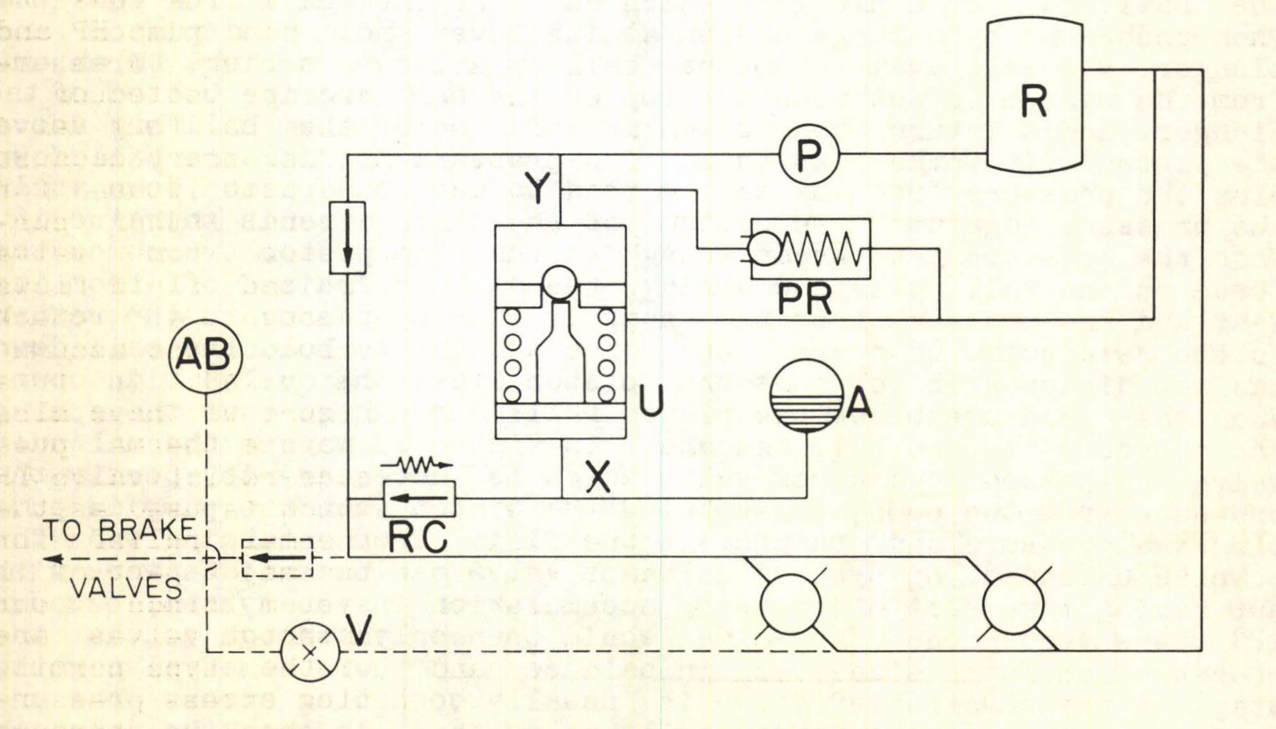


FIG. 11 SCHEMATIC DIAGRAM OF RUDIMENTARY POWER SYSTEM WITH UNLOADER AND RESTRICTOR VALVES

That is, basically, the power system as used in the B-25.There are, however, some additions which we should look into. We have a power brake system on the airplane and, naturally, want the general power system to supply the energy for its operation. It is necessary that the pilot have the use of his brakes when landing the ship even though the general hydraulic system has failed. In order to do this it would appear necessary to have some energy stored up for use of the brakes and nothing else. This we do as indicated by the dotted lines in Figure 11. First we install a separate accumulator AB which can store most of the necessary energy. Then we put in a check valve so that the accumulator can be charged by the pumps every time they are loaded; but, once the energy is in the brake accumulator,it cannot escape except to the brakes. There is another valve V shown dotted in the Figure. This is simply a shut-off valve and should be closed at all times. Its purpose is to make it possible to let the pressure out of the system when the mechanic wants to work on the system or when filling the reservoir.

We said above that the brake accumulator was capable of supplying most of the energy required for the brakes if the general hydraulic system had failed. The remainder of the energy must be supplied by the hand pump. How this is connected into the brake circuit sothat this is possible, is shown in Figure 12. In this figure the power system has been omitted except for a dotted line indicating where it ties in. The reservoir has a separate connection right on the bottom for the exclusive use of the hand pump. From this special connection a line runs to the hand pump HP and from there to an emergency selector valve PS. This valve is necessary because the pump is used for several other purposes. From valve PS the fluid flows through a check valve to the accumulator AB. In this figure we have also shown a thermal pressure relief valve TR which is used as the thermal relief for the major part of the system since our selector valves are of the type permitting excess pressure to back up through the "leaky" check valves as in Figure 8.

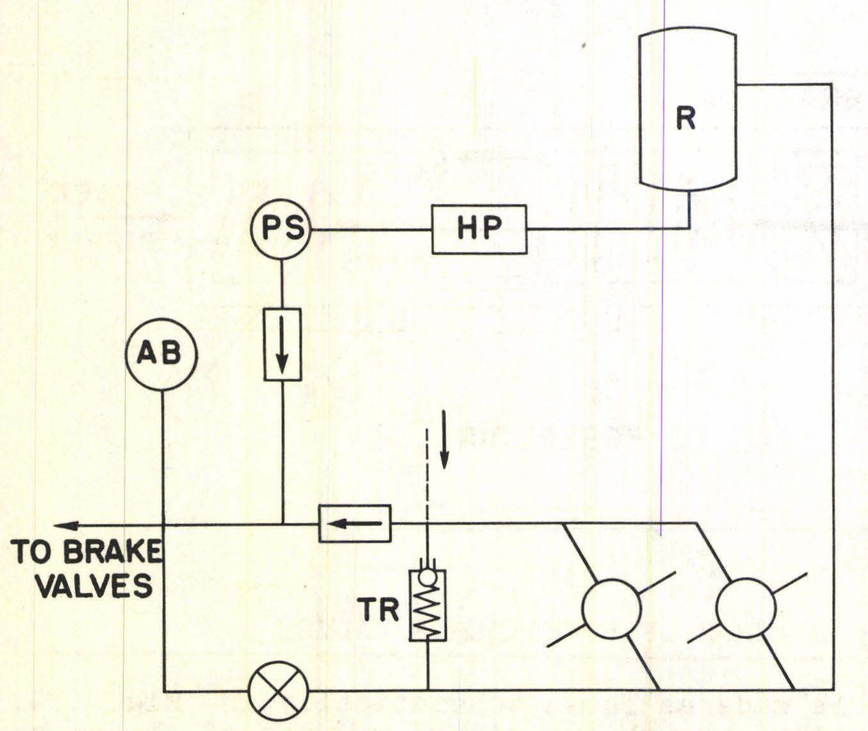


FIG. 12 SCHEMATIC DIAGRAM OF POWER BRAKE SYSTEM

Now let's get a look at some of the special sub-systems used on this airplane. We have seen how the brake system gets its supply of power so now we will see how this power is used. In Figure 12 we started a line out to the brake valves but did not carry it any further. Figure 13 picks it up where it left off and carries it through to the brake itself. There are two independent brake systems, one for each wheel, but since they are just alike we have shown only one of them. In Figure 13, we have shown a conventional power brake valve since all of them are the same in principle, differing only in the details. The pressure enters the valve at the right-hand end and, if the pedal be not pressed, the pressure can go no farther because it is stopped by the valve (1). There is a light spring which tends to return the valve to its seat. The pressure poppet (1) is rigidly connected to the return poppet (2) so that when the valve (1) is seated, valve (2) can move no farther to the left. Valve (2) seats in a movable piston which moves farther to the left and thus connects the line to the brake with the reservoir. As the pedal is pushed down the first thing that happens is that the poppet (2) is seated on the piston, thus sealing off the return; then, as the pedal is pushed farther the poppet (1) is lifted off from its seat, letting pressure through and to the brake. As the pressure rises in the brake line, it pushes harder and harder against the sliding piston and finally reaches a point where it overcomes the pedal pressure, and moves enough to the left to allow the pressure poppet to close. The harder the pedal is pushed the higher will be the brake line pressure required to overcome it, and consequently the higher will be the brake pressure applied to the brakes.

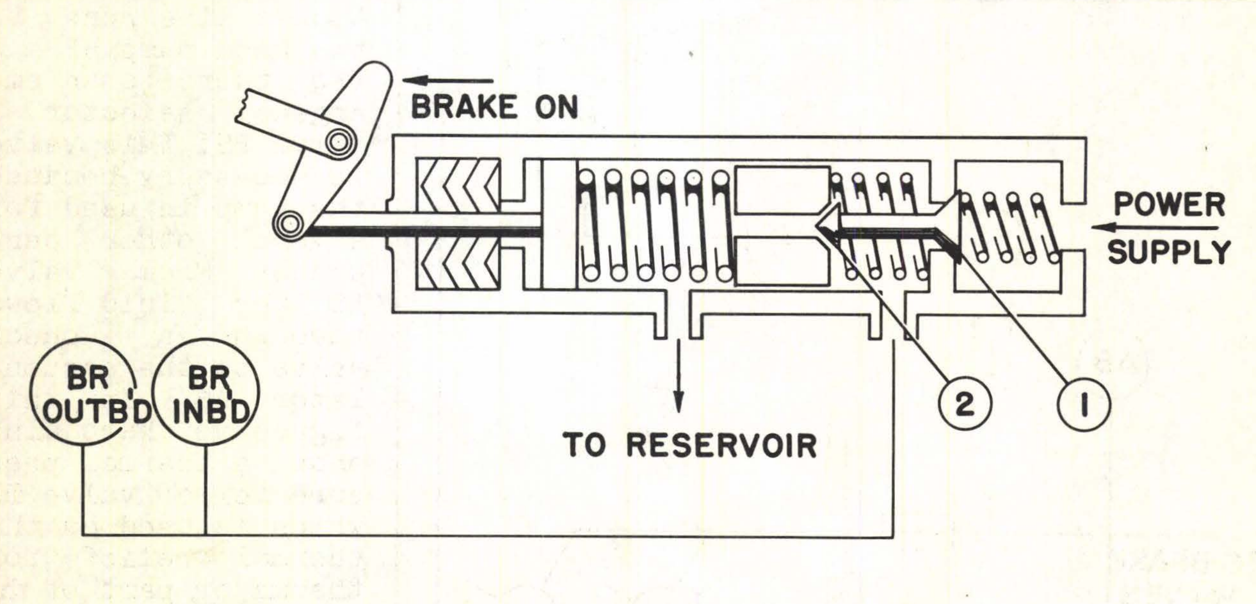


FIG. 13 SCHEMATIC DIAGRAM OF POWER BRAKE VALVE

The brake itself is made as shown schematically in Fig. 14. This figure shows a section through one side of only one of the brakes although there are two brakes per wheel. In the first place, there is an anchorage which serves to support the stator plates of the brake

and to keep them from turning. These stator plates are keyed to the anchor so that they may slide endways, and the anchor in turn is bolted fast to the axle. At the outer end of the anchor (the left end of the Figure) is an annular groove which acts as the operating cylinder, in which is a synthetic rubber cup serving as a seal for the piston which is, of course, ring shaped. When pressure is introduced into the cylinder this piston is forced to the right, thus moving the plates together tightly. Between the stator plates are rotor plates which, being keyed to the wheel, turn with the wheel so that when the stack of plates is pressed together the friction between them tends to prevent relative motion and consequently acts as a brake. If we would consider that there is no friction in the keys we see that if we put ten pounds force on the outermost plate, that plate will move to the right putting the same force on the next plate, etc., so that the force holding all the rubbing surfaces in contact is the same for every surface; so each surface does the same amount of braking. This is not quite true because there is friction in the keys, so actually the plates nearest the cylinder do a little more work than those farther away although the difference is very small. When brakes are applied they get hot, as is to be expected, since all they do is convert the kinetic energy in the moving airplane into heat.

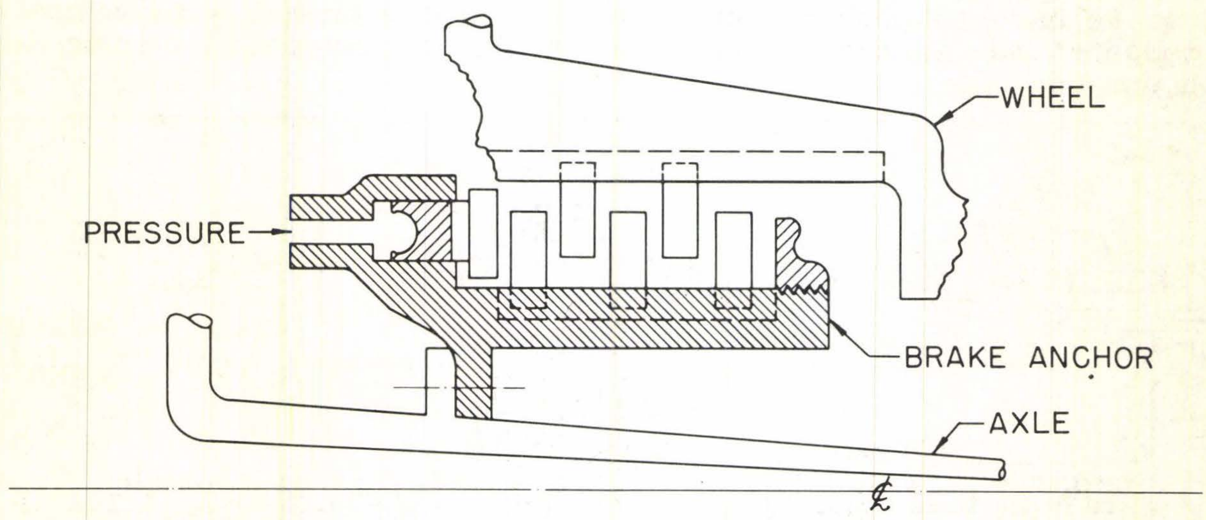


FIG. 14 SCHEMATIC DIAGRAM OF BRAKE

We might look next at the special sub-system which is used for retraction of the main landing gear. This is shown diagrammatically in Figure 15.

At the upper right corner we see the selector valve V, with the pressure and reservoir lines indicated. Next to it we see the up-latch release cylinder UL, which is connected to the down line and the up line so that when pressure is put in the down line the latch will be opened. It would not have to be connected to the up line except that it is wise to be sure that its piston is not stuck in the open position so the latch would not catch the gear when re-

tracted. Next to the left and at the top, we find the down-latch release cylinder DL which is connected into the down and up lines so that it will unlatch when pressure is put in the up line. This is just the same, diagrammatically, as the up-latch cylinder except that it is connected in just the opposite direction. When we put pressure in the up line we want the latch to operate before there is any tendency for the gear to retract, because in order to make the actual latch husky enough, we have had to use a type of latch pin which tends to bind when under load. (This is not true of the up-latch). In order to accomplish this we have put in a timing valve TV which is operated by the latch pin when it is withdrawn. In the diagram this is shown immediately below DL, and in such a position that the piston of DL would operate it. TV consists of two check valves in one housing so arranged that they may be forced open mechanically. We see that TV is so connected that the left-hand check will prevent oil from passing from the up line to the cylinder C until DL has forced it open. It is also evident that returning oil cannot flow from the down side of the cylinder until the valve TV is opened by DL. Thus we can neither get pressure in nor out of the cylinder until the latch is open. Notice that this timing valve does not at anytime prevent the lowering of the gear because the oil going either to or from the cylinder under "down" conditions will just flow by the checks. This timing valve does prevent any flow out of the down side of the cylinder when the gear is down and locked, so we have to provide some relief for the increase in volume due to temperature. A thermal relief valve RV is connected as shown for this purpose.

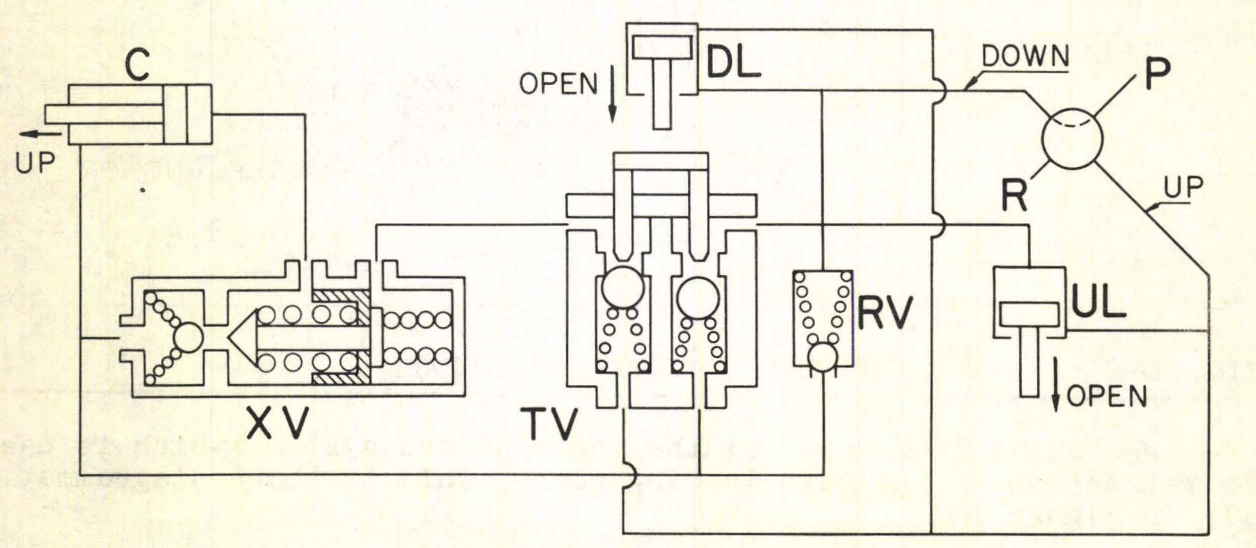


FIG. 15 SCHEMATIC DIAGRAM OF MAIN GEAR RETRACTING SYSTEM

The landing gear of the B-25 will partially extend just due to its weight and it will do it faster than the engine-driven pumps in the hydraulic system can supply oil to the retracting cylinders.

When the gear got to this partially extended position it would just wait for the pumps to catch up if we did not take care of this condition. The valve which lets the oil coming out of the up side of the cylinder flow around and go into the down side, while the gear is extending itself, is called a cross-flow valve and is diagrammed at XV. You will see that oil coming out of the up side of the cylinder enters the valve XV at the middle and moves the floating piston to the right thus opening the cone-shaped poppet valve. This permits the oil to flow through the check valve in the left end of XV and back to the down side of the cylinder. When the gear has reached the end of its travel, under the influence of gravity alone it will have to be pushed the rest of the way by the cylinder which requires pressure in the down line. This causes no trouble because the check valve simply closes again and prevents the pressure going where it is not wanted at the moment. We have to have the floating piston in the valve XV so that when we retract the gear, the pressure in the up line will not open the poppet and go to both up and down sides of the cylinder.

While we are on the landing gear system let's investigate the portion of it which goes to the nose wheel. This is shown in Fig.16. The selector valve V shown at the extreme right is actually the same one which controls the main gear. Just to the left of V is the down latch operating cylinder DL, connected in so that it opens when we put pressure into the up-line to retract the gear. The down latch on the nose wheel is not loaded and so requires no timing valve as does the down latch on the main gear. On the other hand the up latch may, under some conditions, have just a little too much load on it to open when desired; so we have put a timing valve TV on it. TV is a very simple valve as can be seen, and is operated by the up latch operating cylinder UL.

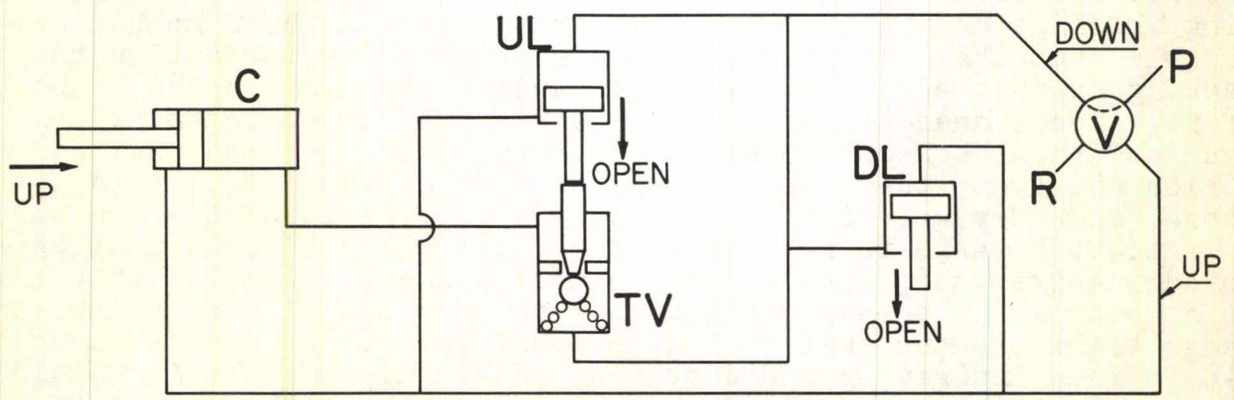


FIG. 16 SCHEMATIC DIAGRAM OF NOSE GEAR RETRACTING SYSTEM

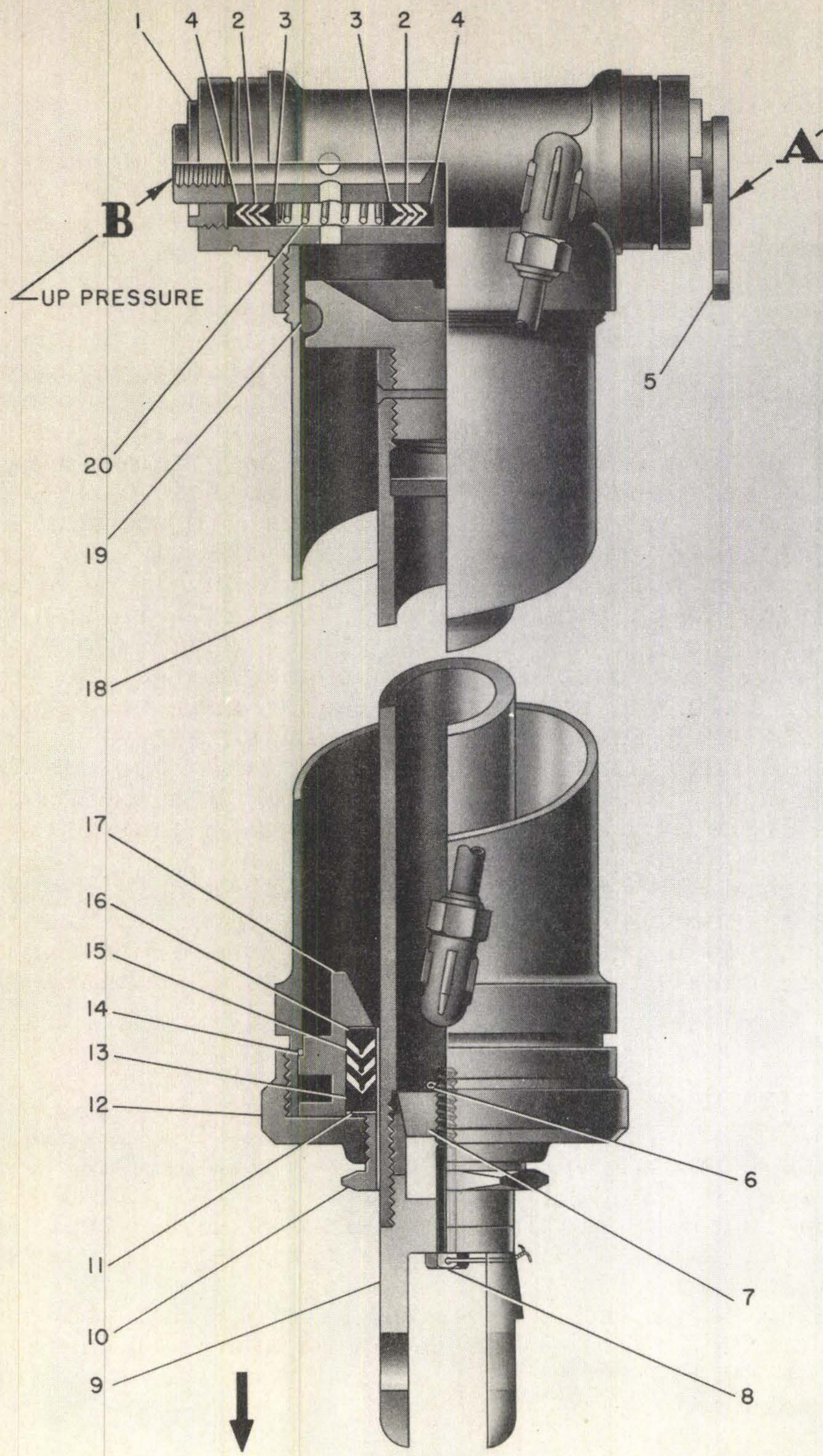
All other hydraulic sub-systems on the airplane are perfectly straight going with no trick features, so we will not take them up.

PART III

At last we have gotten to the construction and adjustment of the actual parts used on the B-25C.

LANDING GEAR OPERATING STRUT

It seems to make little difference in which order we take up the units so let's start with the Main Landing Gear Retracting System. The part which really does the work is the Operating Strut (NAA Dwg. 62-58026) which is shown in Fig. 17. Since this cylinder moves through a considerable angle while operating, we have provided it with a "swivel head" rather than connecting it up with flexible hose. The "swivel head" is shown at the top end of the cylinder and consists of a central pin (5) which is fastened to the structure by means of the lug shown at the right end of the pin and thus is kept from turning. A hole is drilled axially in each end of the pin for passage of oil, and radial holes are drilled to meet these at about the quarter points. Chevron packings are put around the pin on each side of these radial holes to confine the oil. These packings are held in the swivel housing and have no adjustment, the variations in thickness being taken up by springs. The packings face each other and the load always comes on them in the same direction so that springs are quite successful. Oil from one end of the pin is admitted directly into the end of the cylinder and from the other end of the pin is carried through an external tube to the rod end of the cylinder. This external tube is made from steel, not because the strength is needed, but because the steel will stand more abuse when cylinders are kept in stock. The swivel head is screwed and sweat-soldered to the cylinder barrel in order to prevent leaks and to keep it from coming unscrewed. The joint is screwed up very tightly so that it is preloaded and no load comes on the solder. The cap at the rod end of the cylinderis screwed on and sealed by a synthetic ring which is entirely confined so that there has been no history of trouble from their blowing out. There is an adjusting nut on the rod packing at this end, but a word of caution is in order about the use of it. Don't draw it up tight. The best way to do is to pull it up snug and then back off about half a turn. When chevron packings are pulled up tight, they do not seal so well as when they are a little loose, and they wear out very quickly. The clevis on the rod end is a little too large to go through the chevron seals so it must be removed whenever they have to be replaced. You will notice that there is a bolt which screws lengthwise through the clevis and pulls a wedge tight on the inside of the rod. This is a lock to keep the clevis from unscrewing and serves no other purpose, but it should be reasonably tight. The clevis should always be tightened clear home as it is not intended that it be adjustable. The piston head is screwed into the rod and a rivet is put through to safety it. There should be no need of ever removing it. A leak through the threaded joint is rendered harmless by a plug sweated into the rod. The piston packing used here and in most of the operating cylinders, is simply a synthetic ring of a shape similar to a baby's teething ring which is snapped into place. Be sure that in replacing any of these



1.	BEARING
2.	RINGS - PACKING
3.	RING - BASE
4.	RING - CAP
5.	PIN
6.	COTTER
7.	CONE
8.	BOLT
9.	CLEVIS
10.	NUT
11.	WASHER
12.	END
13.	RING - CAP
14.	GASKET
15.	RINGS - PACKING
16.	RING - BASE
17.	RETAINER
18.	ASSEMBLY - PISTON
19.	RING - PACKING
20.	SPRING

62-58026

FIG. 17 LANDING GEAR OPERATING STRUT

teething rings the proper one is used; because the whole secret of their working is that the shape and size are just right.

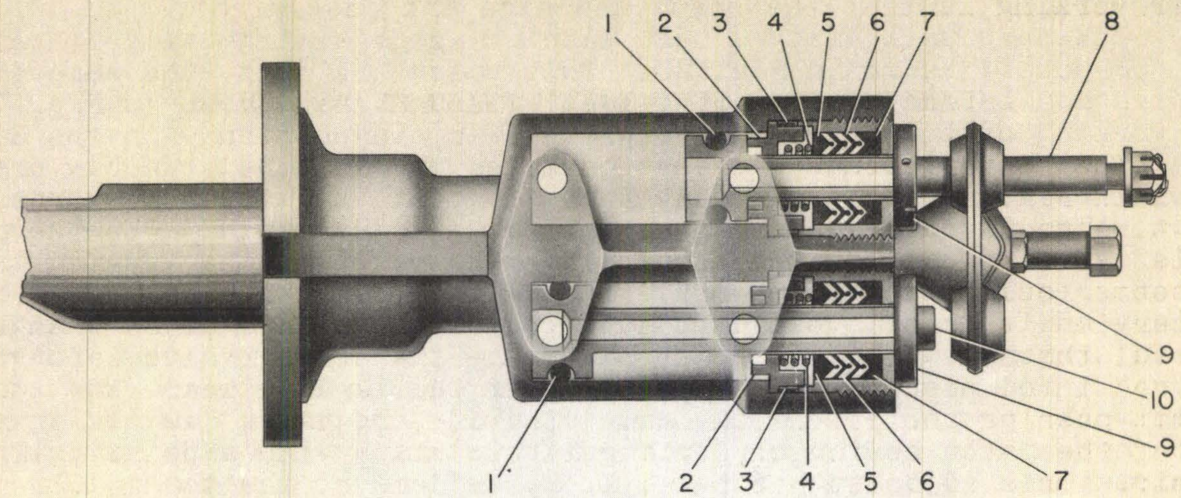
LANDING GEAR DOWN LATCH RELEASE CYLINDER

The Down Latch Release Cylinder (N.A.A. Dwg. 62-58092) is shown in Fig. 18. It is really the lower cylinder of the assembly shown. The latch is released when the piston is moved to the right. It is so simple in design and there are no adjustments possible; so it seems foolish to spend any time talking about it. The only word of caution is that when installing new chevron packings, be very careful that the lips of the packing are not injured when slipping the rod into place. The upper cylinder is an emergency device to permit pushing the latch pin home if, for any reason such as breakage of the latch spring or dirt in the latch, it did not go home of itself. This cylinder has but one connection to the hydraulic system, and that is to the emergency selector valve so that the hand pump may be used. The piston moves to the left when operating and the left end of the cylinder must be vented at all times. This seems to be a good place to point out that this is purely an emergency feature to push the latch pin home, and will not in any way help put the landing gear down. In fact, if it is used before the gear is fully down it will be impossible for the gear to go the rest of the way. After it is used the emergency selector must be returned to the "Normal" position because the latch cannot be withdrawn unless it is. This would not normally be any hardship because the emergency system would not have been used, unless something were wrong which should be looked into before the ship is again flown.

We do not illustrate the landing gear up latch release cylinder (62-58093) because the construction and the inner parts are just the same as in the down latch release, with the exception of the outward shape of the housing. The piston extends to unlatch the gear.

LANDING GEAR CROSS FLOW VALVE

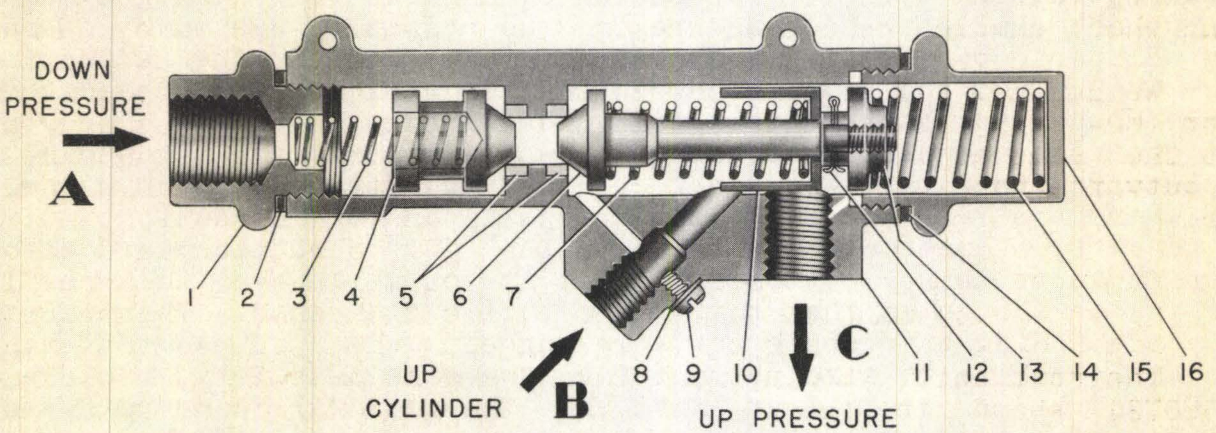
The next unit, the Landing Gear Cross Flow Valve (N.A.A. Dwg. 62-58072) shown in Fig. 19 is only the actual parts which were illustrated in Fig. 15 in diagrammatic form. You will see that the diagram and the part itself are so nearly alike that very little explanation would be called for. Port A connects to the "Down Cylinder" port of the timing valve (of which more later), and to the "DOWN" side of the cylinder. Port B to the "UP" side of the cylinder, Port C to the "UP CYLINDER" port of the timing valve. There are no adjustments to make on the valve.



1. RING-PACKING
2. RETAINER
3. GASKET
4. SPRING
5. RING-BASE
6. RINGS-PACKING
7. RING-CAP
8. PISTON
9. BEARING
10. PISTON

62-58092

FIG. 18 LANDING GEAR DOWN LATCH RELEASE CYLINDER



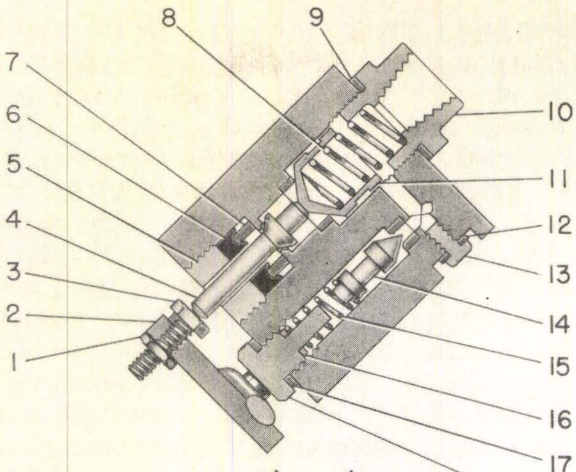
1. END
2. WASHER
3. SPRING
4. VALVE
5. BUSHING
6. VALVE
7. SPRING
8. WASHER
9. SCREW
10. RESTRICTOR
11. ASSEMBLY-BODY
12. COTTER
13. NUT
14. WASHER
15. SPRING
16. HOUSING

62A-58072

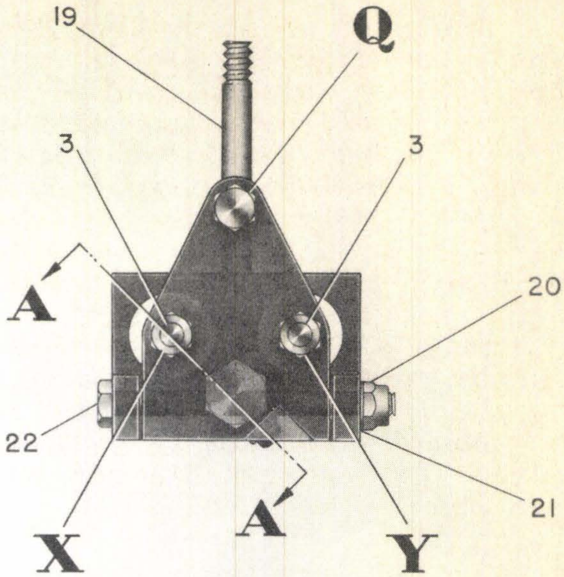
FIG. 19 LANDING GEAR CROSS FLOW VALVE

LANDING GEAR TIMING VALVE

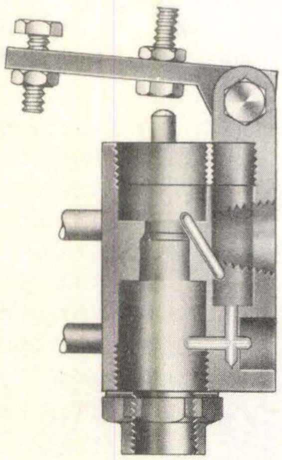
The next unit is the main landing gear timing valve (N.A.A. Dwg. 62-58067) shown in Fig. 20. This valve is just the same as a combination in one housing of valves TV and RV as shown in Fig. 15. The working of the valves was explained in conjunction with the diagram, but the adjustment had best be taken up with the assembly drawing as reference. In section AA we see that the internal parts of the timing valve proper do not have any adjustments. The thermal relief valve is adjusted by means of washers under the spring to a relief pressure of about 1400 lb./sq.in., but this is set at the factory and we see no reason that it should ever have to be changed. The adjustments of the external parts of the timing valve are very important and must be done correctly if the landing gear retraction is to work properly. In the end view of the valve we see an arm which appears to be roughly triangular in shape with a point up. This carries three adjusting screws, X, Y, and one at the top Q. If you will push the arm back and forth you will feel the point at which the screw at X makes contact with its valve plunger. This should occur when the arm is just about parallel to the end face of the valve body. If not, adjust it so that it will be with the arm in this position, next adjust the screw Y so that there is .010 clearance between it and the valve plunger when the plunger is in contact with the valve. In other words, adjust the screws X and Y so that valve X opens .010 before valve Y. The setting of the third screw Q, which makes contact with an acorn nut on the landing gear down lock, is a little harder simply because it must be done with some pressure on the retracting system. Put the ship on jacks with the gear down and locked. Relieve the pressure in the hydraulic system by operating flaps or by opening the exhaust valve. Screw the adjusting screw away from the down latch so that it will not be pushed when the lock opens. Put the selector valve handle in the landing gear "UP" position and hand pump enough pressure so that the latch pin is completely withdrawn. Now screw out the adjusting screw to a position where the landing gear just creeps in an "UP" direction. Give the screw five more complete turns in the "OUT" direction, and check to see that it is not bottomed. If it is you will have to screw it back in far enough so that there is a little clearance. Then safety it by tightening the check nut. We suggest that you use the hand pump while making this adjustment for the sake of safety, because a test stand may supply oil so fast that the gear will come up faster than you can keep out of its way. If your test stand can be made to pump very slowly it may be safe to use; but remember the danger involved.

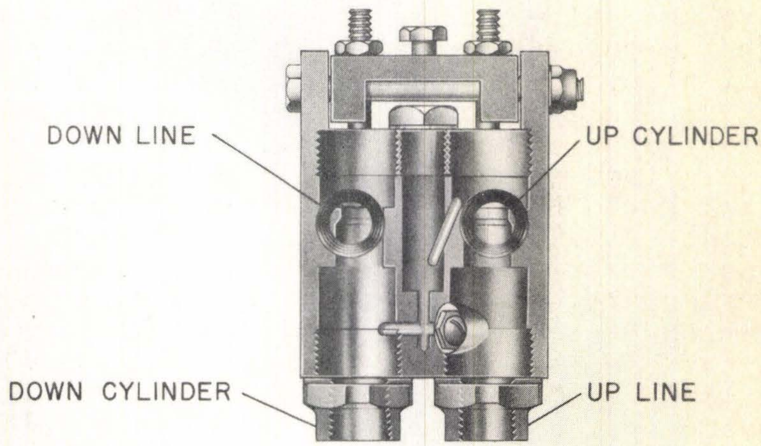


SECTION **A-A**



NOTE:
PARTS AND ARRANGEMENT IN CHAMBER OF VALVE "Y" SAME AS SHOWN ABOVE FOR VALVE "X".





1.	NUT	12.	WASHER
2.	ARM	13.	SCREW
3.	BOLT	14.	VALVE
4.	PLUNGER	15.	SPRING
5.	BEARING	16.	WASHER
6.	CUP	17.	WASHER
7.	RETAINER	18.	PLUG
8.	SPRING	19.	STUD
9.	WASHER	20.	NUT
10.	END	21.	WASHER
11.	VALVE	22.	BOLT

62-58067

FIG. 20 LANDING GEAR TIMING VALVE

NOSE WHEEL UP LOCK TIMING VALVE

The nose wheel up lock timing valve (N.A.A. part No. 62-58065) is made as shown in Fig. 21. In Fig. 16 we showed the "DOWN" pressure from the selector valve connected to both the up lock and this timing valve. This connection to the timing valve is made at Port A and we can see that the poppet in the valve would prevent flow through it in this direction until after the lever (1) is moved to the left. This is done by the UP lock when the gear is released after which fluid can flow through the timing valve from Port A to Port B and thence to the "down" side of the retracting cylinder. In order that the system function properly it is necessary that the adjustment of the timing valve be correct. If the valve did not open the retracting cylinder could get no pressure to force the gear into the locked position when extended and if the timing valve opens too soon the retracting cylinder would greatly increase the load required to open the UP lock and it might not release the gear. To adjust the timing valve we proceed as follows. First we put the ship on jacks and connect up a ground test stand, if available. (If no ground test equipment is available the check can be made by use of the hand pump in "NORMAL" position). Next we loosen the check nut (2) and unscrew the screw (3) far enough so that it will not push the plunger (4). Then we put the landing gear selector valve in the "UP" position and retract the nose wheel about half way and then move the valve handle to "DOWN". The main gear will extend and lock but the nose wheel will not extend more than a little way when it will stop. Keep hydraulic pressure in the system while you slowly and carefully screw "IN" on screw (3) until the nose wheel begins to creep down. Turn the screw "IN" once and one-half to two complete revolutions and lock it in that position with the nut (2).Push the lever (1) to be sure that it can go farther and the valve is not bottomed. Finally release the hydraulic pressure in the system and check to see that the end of the roller slot in the UP lock hook is in a position well past the center of the roller on the gear (so that the roller would pull out of the hook) at the time the valve poppet begins to open. You can feel this point quite easily.Caution: Remember that the nose wheel will fall part way the minute it is released by the hook.

SELECTOR VALVE

The next unit we will take up is the Selector Valve (N. A. A. Dwg. 62-58011) shown in Fig. 22. There are two double units used in the ship for the control of the landing gear, wing flaps, and right and left ending cowl flaps. All are alike, so this explanation of one unit will serve for all.Beginning at the bottom of the illustration we find that the oil enters through port P and flows to the right through the passage shown and past the check valve. This check valve is to prevent interflow between circuits, as we talked about before, and it is also a leaky check valve so that thermal pressures can get by it. In order to keep the leak small we have to use a very small opening; in fact it would be so small that we could not drill a hole small enough, and even if we could it would plug up

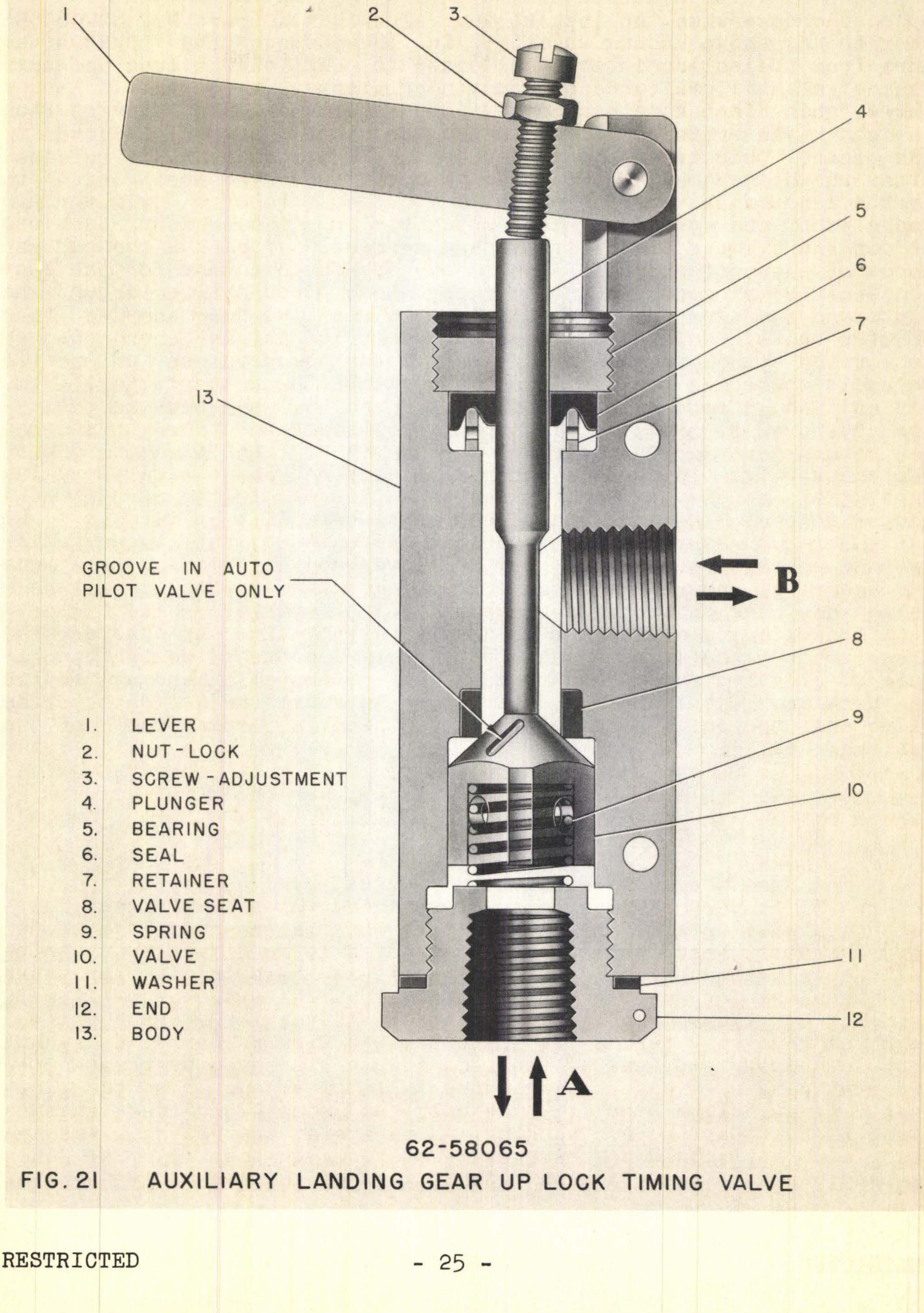
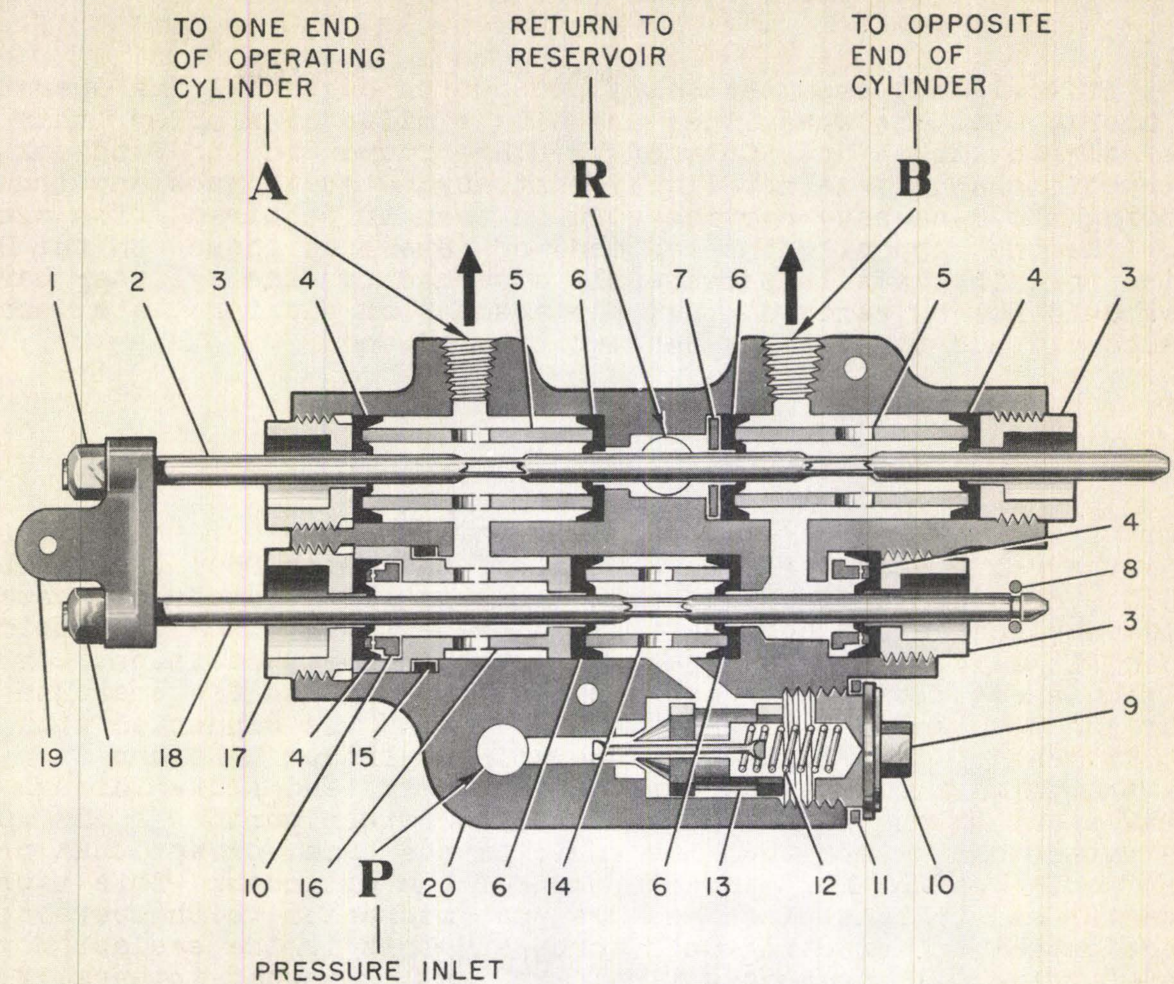


FIG. 21 AUXILIARY LANDING GEAR UP LOCK TIMING VALVE

very quickly. To avoid this difficulty we drill a good sized hole and then fill it up with a pin which is just enough smaller than the hole so that we get the leak we want. This has the further advantage that the pin moves back and forth in the hole and thus keeps the dirt from collecting in the small passage. The exact amount of leak is not at all critical, and anything from say ten drops to two or three cubic inches per minute at 1000 PSI will do. After passing the check valve the oil flows upward through the diagonal passage to the central chamber in the valve body. With the parts in the positions shown (neutral) the oil can go no farther because it is sealed by the lips of the cups at either end of the chamber. Going through the chamber and sealed by the cups is a rod (18) which has slots through it. These slots are shown in the center of the chamber and hence have no effect; but, if the rod were moved to the left so that these slots bridged across the cups, the oil could flow through the slots and thus get by the cups. This is what is done when we "turn on" the valve. Now the oil has reached the center left-hand chamber from which it flows up through the passages shown and out port A which is connected to some operating unit. The returning oil from the unit would come back through port B and, if the slot in the upper rod were to the left, it would flow past the upper cup and out the return port R. In order to see how it is that oil can get to the check valve in case of thermal expansion, let's take the valve in Neutral as shown. We will say that the oil in the circuit connected to port B expands and hence flows back into B. It can't get out the return port because the seal prevents it, but it can go into the center compartment on the lower rod by blowing backwards through the cup. From there it will go through the leaky check valve and back to the main pressure relief valve. While it looks as if the oil could flow out of a unit at any time and thus escape, that is not exactly the case; because the central compartment is full of oil at system pressure and only pressures in excess of this can back up. There are no external or internal adjustments in the valve and the only service it should need is replacement of the sealing cups.

NOSE WHEEL OPERATING STRUT

The nose wheel operating strut (N.A.A. Dwg. 62-58028) shown in Figure 23, is very similar to the strut used for the main gear, differing chiefly in size and the way that the rod end head is attached. This head is held in place by means of a large diameter nut which pulls down against a seal ring. Since it is large in diameter, there is a tendency to overtighten it which should be avoided. It only needs to be tight enough so that there is not a leak around it and anything more only serves to distort the cylinder barrel and cause trouble. The clevis end of the rod does not need to be removed for the replacement of any packing since it is small enough so the packings will all slip over it. The only adjustment provided on this strut is that for the rod packing. Here again, chevron packings are used, and they should not be over-tightened. In installing new ones be very careful that the lip is not injured as the whole sealing



1.	NUT	11.	WASHER
2.	SHAFT	12.	SPRING
3.	BEARING	13.	ASSEMBLY - VALVE
4.	CUP - OUTER	14.	RETAINER - BOTTOM INNER
5.	RETAINER - TOP	15.	GASKET
6.	CUP - INNER	16.	RETAINER - BOTTOM
7.	WASHER	17.	BEARING
8.	RING	18.	SHAFT
9.	PLUG	19.	YOKE
10.	RETAINER - BOTTOM OUTER	20.	BODY

ENGINE COWL FLAP CONTROL VALVE 62-58011
LANDING GEAR AND WING FLAP CONTROL VALVE 62-58011

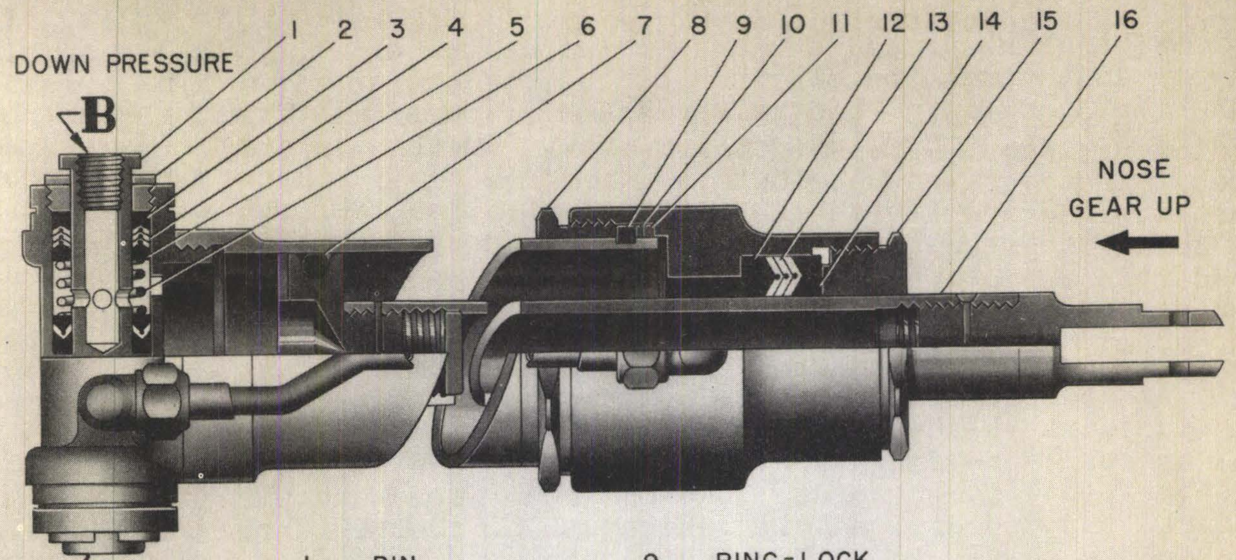
FIG. 22

ability of these or for that matter, any kind of cup, is dependent upon a good contact right at the edge of the lip.

It would not seem necessary to go through all the operating cylinders, etc., because they are all similar or simpler than the ones already taken up. Cuts of them are found in the Handbook of Instructions and it is not likely that anyone would have any trouble in doing the necessary service work on them if required. The closed head (the one opposite the rod end) of every cylinder on the B-25 series of airplanes is permanently attached to the cylinder barrel and should not be removed. All replacement of packings, etc.,should be accomplished through the head at the rod end.

BOMB DOOR CONTROL VALVE

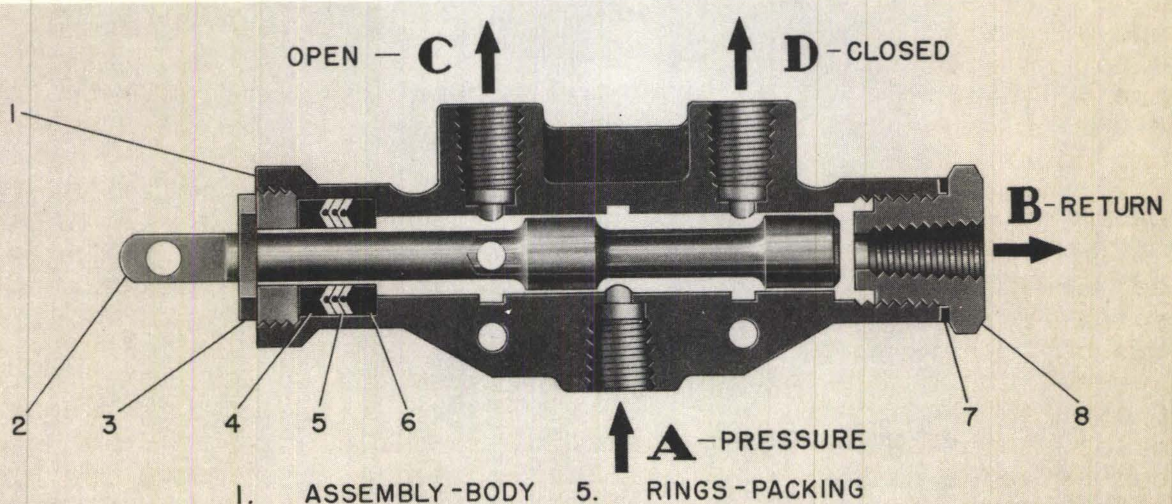
The valve used for the control of the Bomb Door (N.A.A. Dwg. 62-58016) is shown in Figure 24. This is illustrated not because it is complicated but because it is different. It is a conventional lapped fit slide valve and has no usable neutral position. In the position shown fluid enters at the bottom port and flows around the spool and out the port marked "CLOSED", which is connected with the "CLOSED" end of the Bomb Door Operating Cylinder. Return flow enters the valve through the port marked "OPEN" and flows through the hollow spool to the right end and out the return port. If the spool were moved to the left the flow would be the same, except that pressure would go to the opposite end of the cylinder. This type of valve is used in this place because the mechanism which operates it is not capable of exerting much force and this is the easiest moving type of valve, although it will always leak somewhat internally. It is not harmful to have a small leak in the system; but if all valves were of this type, the total leakage would cause frequent operation of the unloader valve. No neutral position is provided because the bomb doors are either open or closed, and any means of returning the valve to neutral is very complicated in its relations to the remainder of the bomb mechanism. A little study will show that there is a slight unbalanced force on the spool which tends to move it to the "OPEN" position. This is done so that if the valve is disconnected from its operating mechanism and someone is working in the bomb bay, there will be a tendency for the valve to stay open and thus not injure the workman by having the doors close on him. A word of caution about work in the bomb bay is in order. If a mechanic is in the bomb bay, every precaution should be taken that the bomb door valve is not moved to the closed position because there may be enough energy in the accumulator to close the doors; and when they close, they close. No man could dodge them since they move in about 1-1/2 seconds. The safest way to do is to disconnect the operating link from the valve and put a U shaped piece of sheet metal over the stem to prevent its being accidentally pushed in. Care must be taken to prevent its being accidentally pushed in. Care must be taken that the valve stem is not bent.



1. PIN
2. BEARING - PIN
3. RING - CAP
4. RINGS - PACKING
5. RING - BASE
6. SPRING
7. RING - PACKING
8. NUT
9. RING - LOCK
10. RING - SPACER
11. GASKET
12. RING - BASE
13. RINGS - PACKING
14. RING - CAP
15. BEARING - PISTON
16. ROD ASSEMBLY - PISTON

62-58028

FIG. 23 NOSE GEAR OPERATING STRUT



1. ASSEMBLY - BODY
2. SHAFT
3. BEARING
4. RING - CAP
5. RINGS - PACKING
6. RING - BASE
7. WASHER
8. END

62-58016

FIG. 24 BOMB DOOR CONTROL VALVE

POWER BRAKE VALVE

The brake pressure port in the center of the valve assembly, is ported through the body to the top of the section. The pressure inlet, at the top of the valve assembly, ports down through the body and is led into the middle (3) as shown in the section.

The system pressure is stopped at the pressure inlet port (3) by the pressure valve (2), which is balanced by the slide valve (5). When a load is applied on the brake pedal it is transferred through the plunger (14) and the balance spring (9), and seats the ball (6) on the lower end of the slide valve (5). This seals off the return port (7) at the bottom from the pressure outlet at the top. When a load is applied on the bottom of the slide valve (5) it forces open the pressure valve (2) which allows the pressure to be delivered to the brakes. The fluid pressure on the brakes is also a down load on the ball (6) and the pedal load is an up load on this ball (6). As long as the pedal load is greater than the fluid pressure on the brakes the valve (2) will remain open, but when the fluid pressure load on the brakes rises high enough to equal the pedal load on the ball (6) the pressure valve (2) will shut off, with the aid of a light spring wrapped around the slide valve (5). When the fluid pressure load on the brakes is large enough to overcome the pedal load the spring (9) is compressed which allows the fluid to pass through the center of valve (5) and out to the reservoir (7), since the ball (6) under this condition is not seated on the lower seat of valve (5). If the pedal load were decreased the brake pressure would push the ball (6) open and allow the pressure to escape into the return port (7).

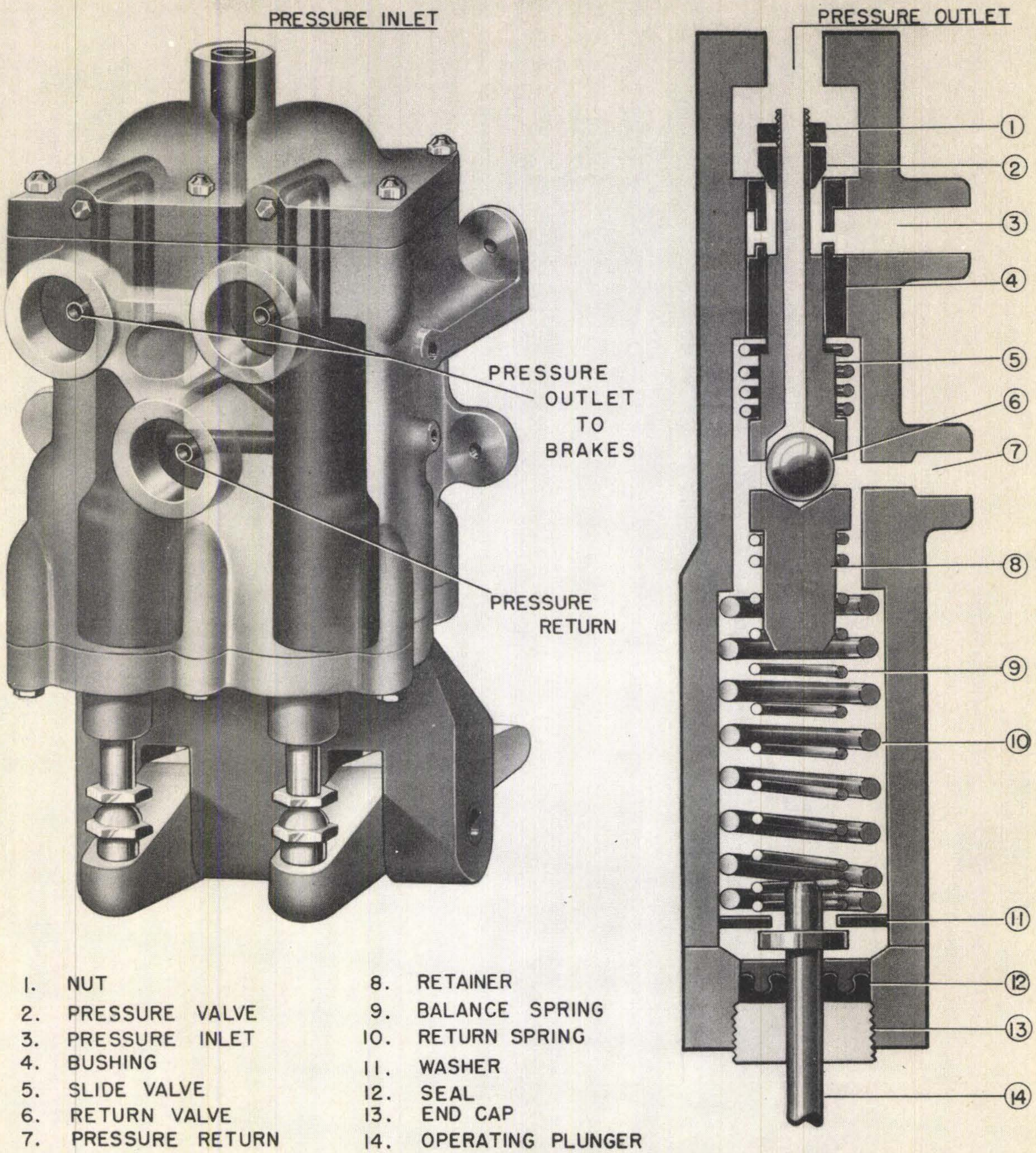
The return spring (10) is provided to return the pedals when the brakes are off, at which time there is no load on balance spring (9).

To clarify the section all rubber cups and gaskets are not shown.

Conclusion: The load on the brakes is equal to the load on the balance spring (9) divided by the area of the ball seat. Hence, the farther the pedals are pushed, the more the balance spring will be compressed, and the load on the brakes will rise proportionately.

BRAKE VALVE INSTALLATION

The adjustment screw (2) limits the plunger travel and the maximum load on the balance spring, hence, the maximum load on the brakes,which should be set at two hundred fifty (250) PSI may be secured by turning the screw in for more pressure. The parking brake adjustment should be made to give no less than two hundred ten (210) PSI. This is done by moving the screw in the slot. When the brake is applied, and the parking brake handle is pulled,the fork or latch holds the brake on. To release the parking brake apply the brake which allows the spring-loaded latch to unlock.

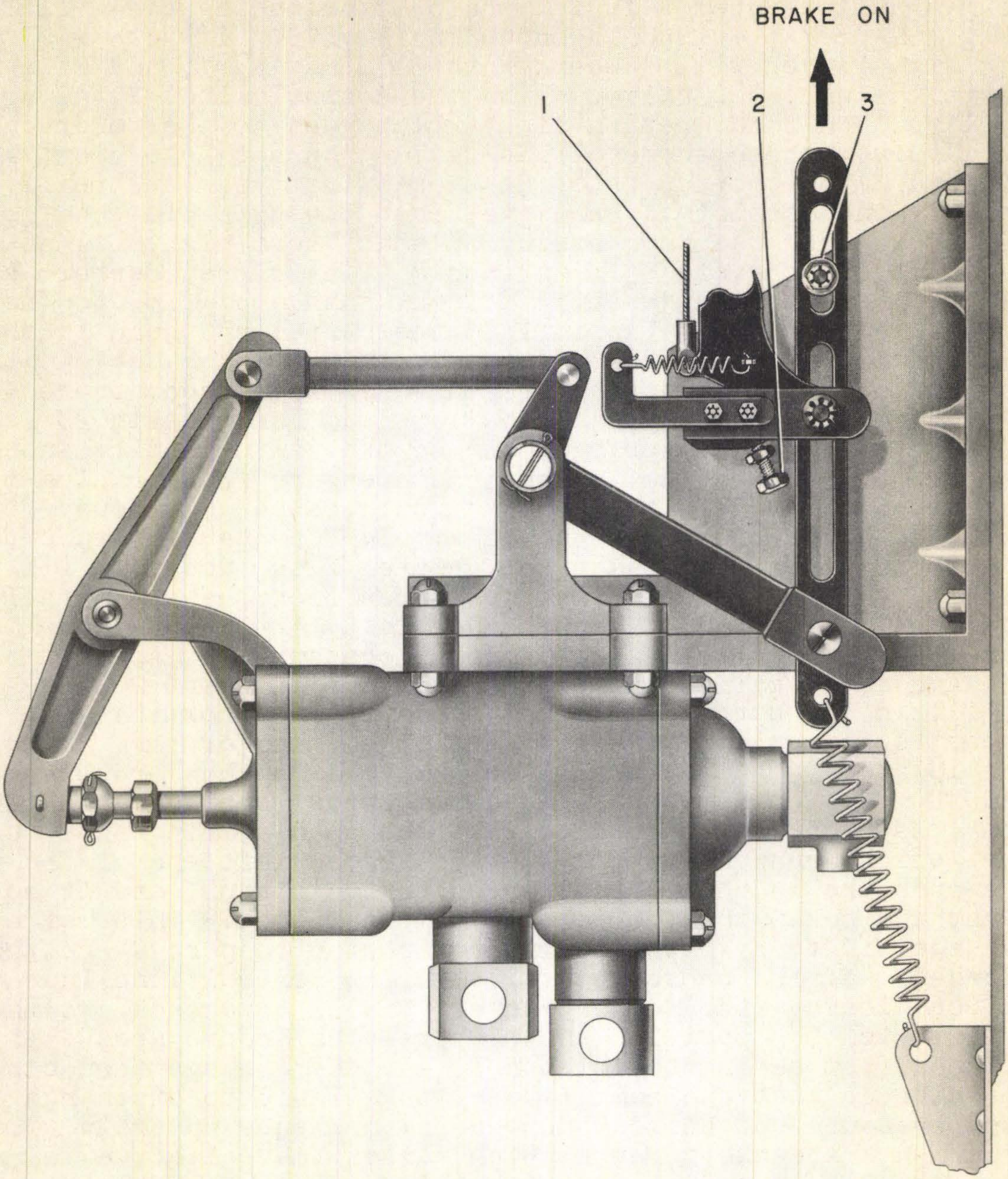


1. NUT
2. PRESSURE VALVE
3. PRESSURE INLET
4. BUSHING
5. SLIDE VALVE
6. RETURN VALVE
7. PRESSURE RETURN
8. RETAINER
9. BALANCE SPRING
10. RETURN SPRING
11. WASHER
12. SEAL
13. END CAP
14. OPERATING PLUNGER

FIG. 24A

82-58078

BRAKE VALVE POWER CONTROL



1. ACTUATING CABLE
2. MAXIMUM PRESSURE ADJUSTMENT
3. PARKING PRESSURE ADJUSTMENT

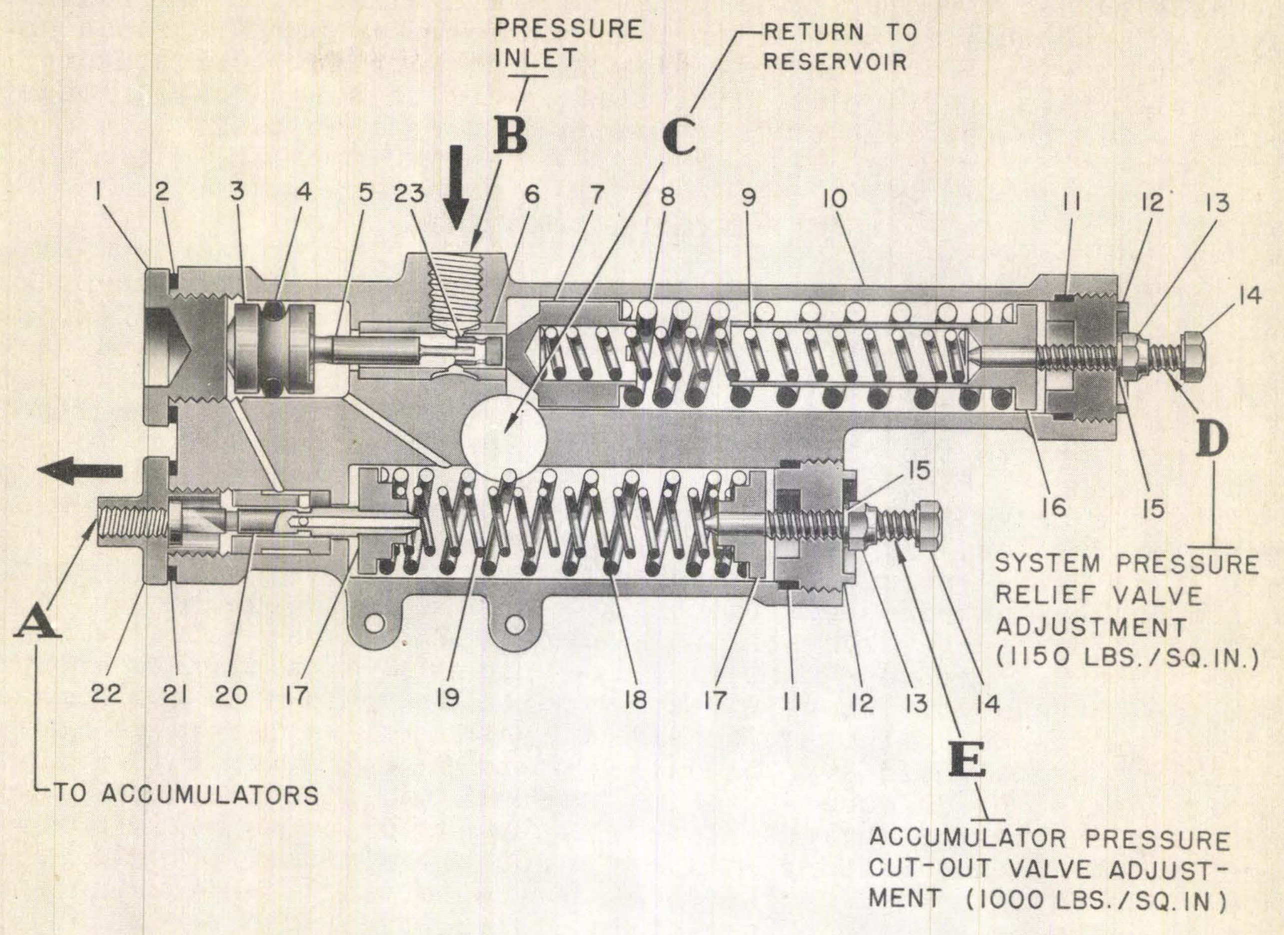
82-58043

FIG. 24B BRAKE VALVE INSTALLATION

ENGINE PUMP UNLOADING AND RELIEF VALVE

The next unit we take up is one of the most important in the entire hydraulic system. It is the pump unloading and relief valve (NAA Dwg. 62-58074) which is shown in Fig.25. If you will refer back to Fig. 11 you will see that three lines X, Y, and Z are connected to the unloader valve. X is the control line, Y the pressure supply line, and Z the return line which goes to the reservoir. On the real valve these three lines would connect X to port A, Y to port B, and Z to port C. Let us look first at the relief valve portion of the assembly. Here we have pressure oil coming in at port B and so long as the pressure is not too high, it can go no further because the pin 5 is a lapped fit in the barrel and its leak is very small,thus shutting off any chance of flow to the left; and the relief pin 23 is lapped into the barrel and held to the left so the cross holes are covered,by the springs 9 and 8 acting through the spring follower 7. As the pressure is increased there comes a time when the pressure against the left end of the pin 23 is great enough to overcome the springs, and so the valve permits enough oil to flow through the port C to keep the pressure from rising higher. If there were a greater flow which would cause a tendency for the pressure to rise, the valve would simply open a little further so that its loss in pressure at the greater flow would still remain practically the same as it was for a less flow. That is all there is to the relief action. The Unloader is a little more complicated. The way it works is this--the control pressure is applied through port A and acts against the left end of the plunger 20 which is a lapped fit in its barrel. If the pressure is below that exerted in the opposite direction against the other end of the pin by the springs 18 and 19, the pin will not move. As the pressure is increased to the point where it overcomes the springs the pin will move to the right far enough so that the annular ring in it uncovers the port which runs diagonally upward to the left end of the piston 3. The pressure is thus transferred to the piston and it moves to the right and pokes the relief valve clear open. This, of course, allows the oil to by-pass freely from port B to port C and the pump is unloaded. If the pressure falls in the control line (due to use of oil, or leaks, etc.) the plunger 20 will move back to the left until it is in the position shown where the groove around it lets the oil out from behind the piston 3, and the springs then close the relief valve so that the pump is no longer able to discharge against very low pressure but builds the general pressure up again. The only adjustments are the screw D which raises the relief valve pressure as it is screwed in,and the screw E which raises the unloading pressure as it is screwed in. The unloading pressure should be between 1000 and 1050 PSI and the relief valve pressure between 1100 and 1200 PSI. Please note that if the Cuno filter is allowed to become dirty the relief valve pressure will rise.

Since we have mentioned the Cuno Filter we may as well say that it is just the same construction as the one used in the power plant and works the same way. Parts are not interchangeable nor are the units as a whole. The cleaning handle should be turned at least one full turn and preferably two turns, at the ten hour inspections;



1. PLUG
2. WASHER
3. PISTON
4. RING
5. PLUNGER
6. SLEEVE
7. RETAINER
8. SPRING
9. SPRING
10. ASSEMBLY - BODY
11. GASKET
12. END
13. NUT
14. SCREW
15. WASHER
16. GUIDE
17. GUIDE
18. SPRING
19. SPRING
20. PLUNGER
21. WASHER
22. END
23. RELIEF PIN

62-58074

FIG. 25 ENGINE PUMP UNLOADING AND RELIEF VALVE

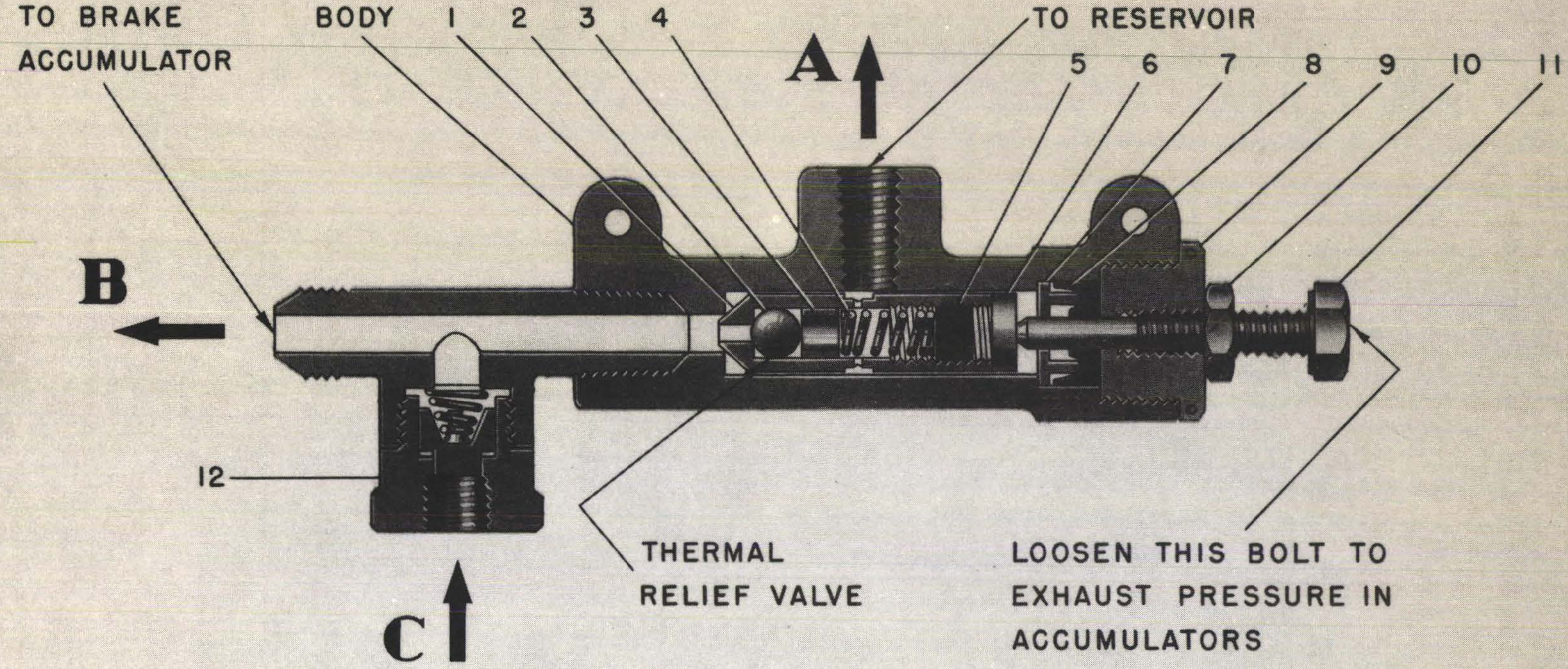
and every fifty hours the plug should be removed from the bottom of the housing and the dirty oil in the filter drained out. Experience may show that this is more often than necessary to perform these operations; but to be on the safe side, and lacking sufficient experience with this particular installation to be sure that a longer period would do, we make our recommendations on that basis.

BRAKE ACCUMULATOR VALVE

The next valve we take up is the one we have called the Brake Accumulator Valve, although the name comes only from its position as it really is a combination of the dotted check valve, and valve V of Fig. 11 and the valve TR of Fig. 12. It is part No. 82-58089 and is shown in Fig. 26. The upper port is connected to the return line, the left port to the brake accumulator, and the lower port to the pressure supply. You will see that the check valve 12 allows oil to go into the brake system from the general hydraulic system but prevents return flow. If we were to loosen up the check nut 10 and the bolt 11 it would permit the tapered valve 1 to move to the right, thus opening a passage from the brake accumulator to the return line. This is the exhaust valve action. Inside the exhaust valve we find a ball type of pressure relief valve which permits oil to escape from the brake accumulator if the pressure is raised to too high a figure. While this might be considered a thermal relief valve it is unlikely that it would ever be called on to function for this reason; but it may be used more often to prevent too high pressures from being applied to the brake system by the hand pump. The relief pressure is set at the factory and it is not likely that it will ever have to be changed (approx. 1500 PSI is the setting). In using the exhaust valve be sure that when it is closed (turning bolt 11 in.)it is not pulled up too tight. The seat is quite small and the taper of the plug is large, so only moderate wrench torque should be necessary to make a tight joint and excessive torque will only have the effect of quickly destroying the valve seat. Needless to say, the check nut should be tightened to prevent the bolt from working loose at the wrong time. The synthetic rubber sealing cup 8 prevents oil from leaking around the bolt and should not require replacement for a very long time. It is evident that it may be replaced by unscrewing the plug 9.

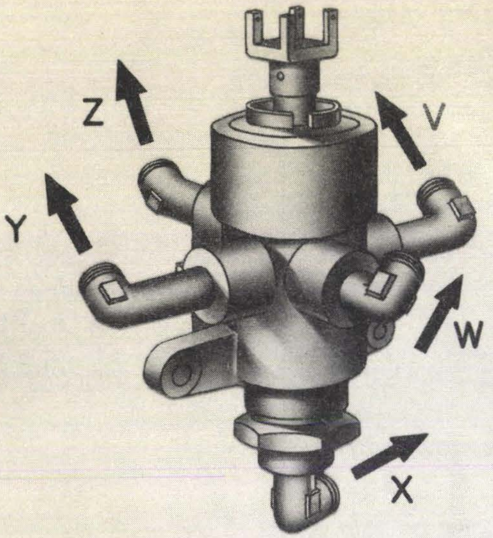
EMERGENCY SYSTEMS SELECTOR VALVE

The valve used to direct the hand pump pressure to the particular system desired is nothing more than a plug cock with a straight lapped plug and packed stem. This valve, (NAA Dwg. 62A-58025) shown in Fig. 27, has a pump pressure inlet port "Z" near the top, a return port out the bottom, and three selective ports so that the hand pump pressure may be directed to "NORMAL" (where the general hydraulic system is supplied), "Brake" (where the brake system alone is supplied), and " Latch" (where the pump supplies pressure to drive the main landing gear latch pins home). It should again be pointed out that this last position <u>must not</u> be used unless the landing gear is completely extended. There is a small ball de-



1. VALVE EXHAUST
2. BALL - STEEL
3. GUIDE
4. SPRING
5. PLUG
6. STOP
7. RETAINER
8. CUP - PACKING
9. END
10. NUT LOCK
11. SCREW
12. VALVE - CHECK

FIG. 26 BRAKE ACCUMULATOR THERMAL RELIEF AND EXHAUST VALVE 82-58089



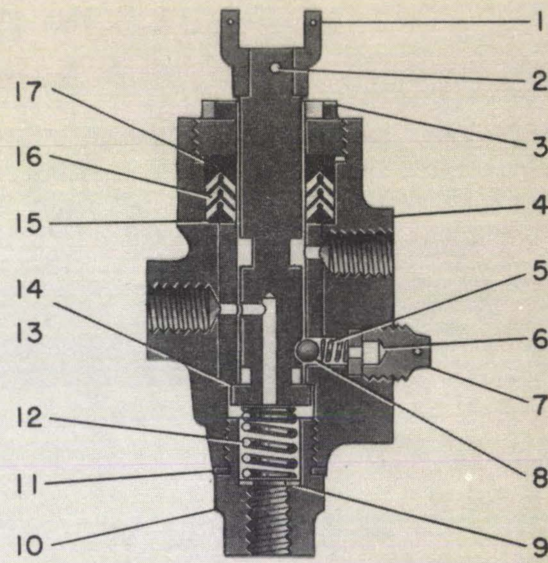
V.-(BRAKES SYSTEM)

W.-(GENERAL SYSTEM)

X.-(TO RESERVOIR)

Y.-(EMERGENCY DOWN LATCH)

Z.-(HAND PUMP PRESSURE)



1. YOKE
2. PIN-TAPER
3. NUT
4. ASSEMBLY-VALVE
5. SPRING
6. GUIDE
7. PLUG
8. BALL-STEEL
9. WASHER
10. PLUG
11. WASHER
12. SPRING
13. WASHER
14. WASHER
15. RING-BASE
16. RINGS-PACKING
17. RING-CAP
18. FITTING

62A-58025

FIG. 27 EMERGENCY SELECTOR VALVE

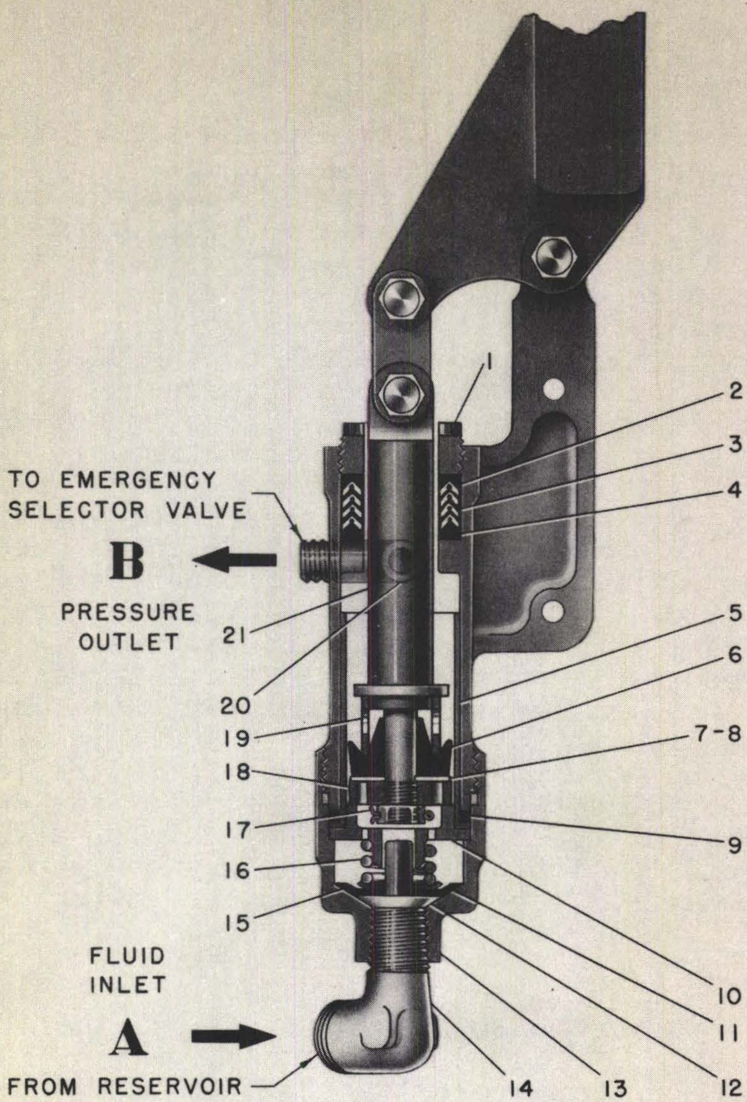
tent to indicate the position of the valve and the name plate at the valve handle shows which system it is set to supply. Keep the handle in "Normal" except when otherwise required.

EMERGENCY HAND PUMP

The Emergency Hand Pump (NAA Dwg. 62-58024) shown in Fig. 28, is what is known as a double acting differential pump. Oil enters the pump cylinder through the elbow 14 and past the suction valve 12 when the pump piston is moved to the top. The volume of fluid which enters is equal to the area of the cylinder times the stroke. For a full stroke this is about one cubic inch. When the piston is moved to the bottom the suction valve prevents oil from escaping to the suction line, so it flows past the cup on the piston and into the space to the top of the piston. Since the rod has a cross-sectional area of about half that of the piston, there is not enough room for half of the oil and it is forced out the discharge line. When the piston again moves to the top, the half of the oil remaining in the top space is forced out into the discharge line, while new oil comes into the bottom space. The suction valve used is unique in that it is a metal poppet valve with a synthetic rubber backing washer (15) so that if a particle of dirt were to hold the metal valve (12) a small distance open, the washer would still seal against leaks and the pump would not quit work. Instead of using a metallic check valve in the piston to let the oil get into the top compartment we use a special synthetic rubber cup (6) with a flexible lip so that it seals in one direction but offers little resistance to flow by it in the other direction. The pump rod is sealed with chevron packings of the usual type, which should last for a very long time since the hand pump is little used. They may be replaced by removing the handle link from the piston rod, unscrewing the bearing 1, removing the old packing, and installing new.

HYDRAULIC ACCUMULATORS

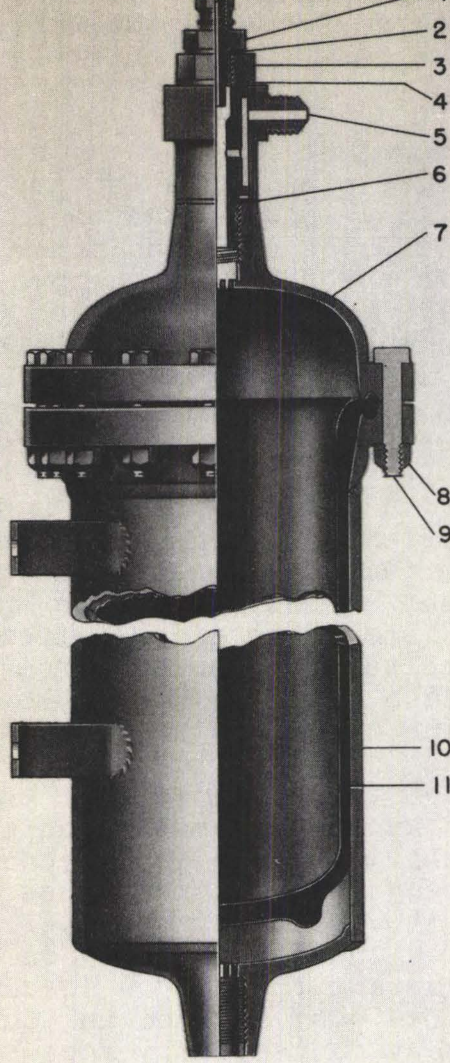
The hydraulic accumulators (NAA Dwg. 62-58376) shown in Fig.29 are very simple. They consist of a tubular steel housing having a lower head welded in place and an upper head bolted on. Inside this housing is a synthetic rubber bag which has its open end flared out to form the gasket between the lower housing and the upper head. Air is pumped into the upper connection to a pressure of 400 PSI when oil enters the bottom it further compresses the air. In order to check the air pressure, which should be not less than 350 or more than 450, the exhaust valve must be opened. Under this condition the pressure gages which are permanently connected to the accumulators will read the "charging pressure". At other times they will read the pressure of the system connected to the particular accumulator. So long as the system pressure is as great as the charging pressure there will be no tendency for the bag or diaphragm to go out through the connection for the oil, but just the minute the system pressure falls below the charging pressure, there is an unbalanced pressure trying to force the diaphragm out. To prevent this



1.	BEARING	8.	WASHER	15.	WASHER
2.	RING-CAP	9.	GASKET	16.	SPRING
3.	RINGS-PACKING	10.	RETAINER	17.	COTTER
4.	RING-BASE	11.	WASHER	18.	HEAD-PISTON
5.	LINER	12.	VALVE	19.	RETAINER
6.	CUP	13.	HEAD-CYLINDER	20.	FITTING
7.	WASHER	14.	FITTING	21.	PISTON

62-58024

FIG. 28 EMERGENCY HAND PUMP



1. VALVE
2. WASHER
3. BOLT
4. WASHER
5. FITTING
6. WASHER
7. HEAD
8. NUT
9. BOLT
10. ASSEMBLY-BODY
11. DIAPHRAGM

62-58376

FIG. 29 HYDRAULIC PRESSURE ACCUMULATOR

occurring we have made the oil port a large number of very small holes and put a fabric patch on the diaphragm to keep it from extruding. We have put some "feet" on the lower end of the diaphragm so that it will normally be held out of contact with the inside of the lower head so that the oil will have a chance to get out. It is important that the charging pressure in the accumulators be maintained in the range stated, because the whole hydraulic system will be sluggish or the brake reserve may entirely disappear if the accumulators are neglected.

The only other important unit of the hydraulic system we have not taken up is the reservoir. This is so simple that we have not illustrated it. There is a sight gage on it to check the level of fluid but this level must be checked under certain conditions, or the reading will be in error by an unknown amount. The glass has markings on it which give the range in which the fluid level is correct if it is read when the landing gear is extended, the flaps up, and, most important of all, when the system and brake accumulators are empty of oil; which is only true if the exhaust valve is used to exhaust all the oil pressure in the airplane.

The next system we take up is not a hydraulic system at all but a compressed air system. This is the emergency air brake system and is exactly what the name implies--an emergency system. It is to be used only in the event of failure of the normal brake system. In general the system consists of an air receiver which holds air under pressure, a valve for releasing the air from the receiver to a separate set of lines to each brake; and shuttle valves to shut off the escape of air through the oil lines when the air system is used. The air receiver is located just to the right of the emergency nose wheel lowering device on the front wall of the navigator's compartment and has a pressure gage permanently connected. Due to its location the gage is plainly visible to anyone entering the forward hatch, and it should always be checked to see that there is sufficient pressure in case it should be needed. The correct pressure is ~~400 PSI~~ + or - 25. Since the receiver may only be replenished while on the ground it is important that it be checked. The air valve for 550 to 600 P.S.I. filling is a regular valve just as used in the tires and is located on the receiver in a very conveniently accessible place. The same equipment which is used to charge the hydraulic accumulators may be used to charge the receiver. At the bottom of the receiver is a drain plug which should be opened and any condensate drained off about every fifth time the receiver is completely recharged. There is a line from the receiver to a poppet type of valve located in the control pedestal. This valve is operated by a handle convenient to both the pilot and co-pilot, and is the only control they have of the brakes when using the air system. It should be noted that there is no differential action and no steering with the brakes possible while using this system. The poppet valve has two poppets--one, which is normally open when the control handle is pushed down (its usual position), connects the line to the brakes with the atmosphere so that no pressure builds up on the brakes when not wanted and also that the brakes may be released after using the air system. Moving the control handle half-way up (an easily felt position) closes this

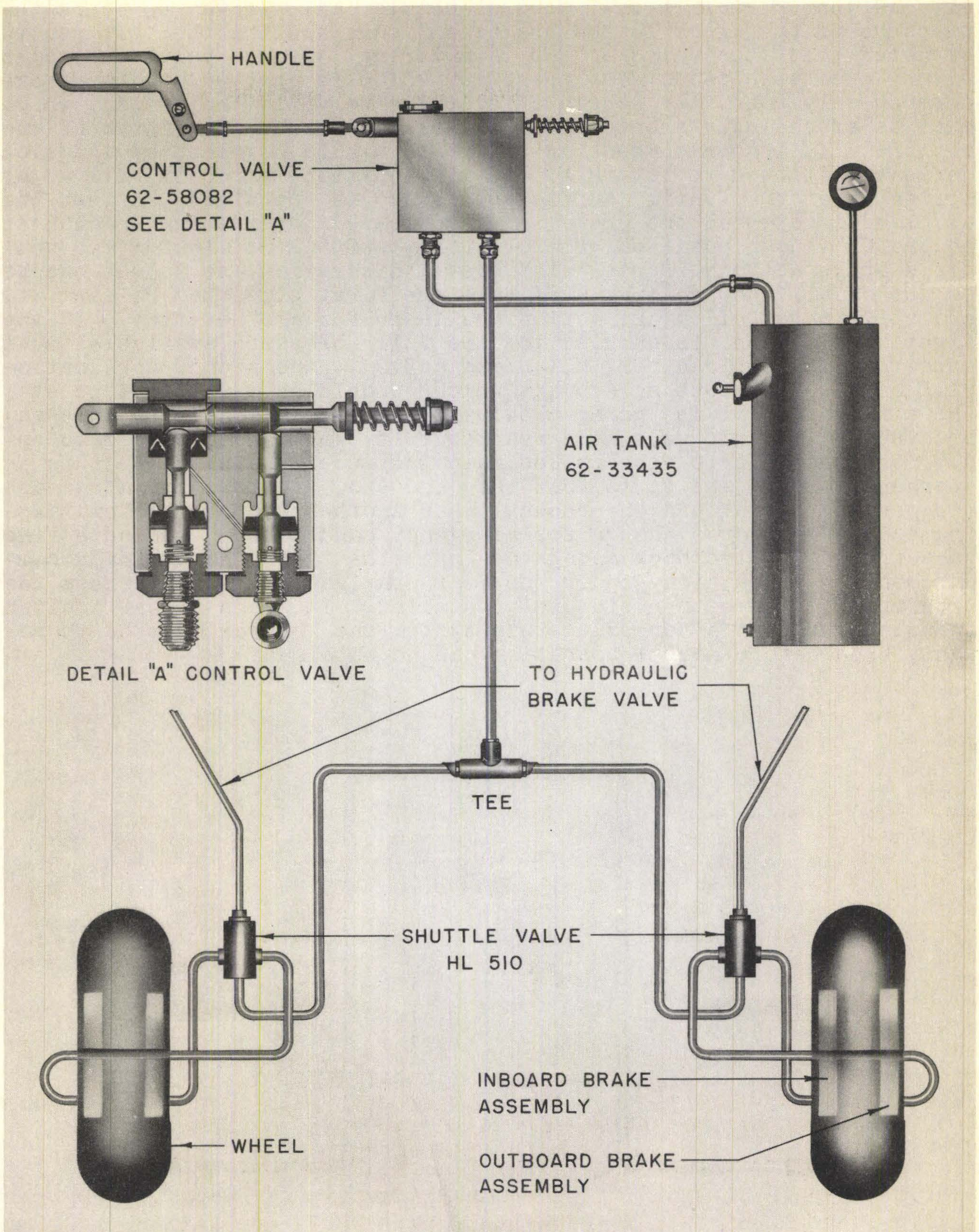


FIG. 30 AIR BRAKE SYSTEM DIAGRAM

off the vent. Pulling the control handle all the way up opens the pressure to the lines to the brakes and thus applies them. It should be noted that the valve is not a metering type of valve and it is either open or closed. The pressure which is applied to the brake depends only upon the length of time the valve is held open, which must be exceedingly short since full brake is obtained in about two seconds. It is our suggestion that this handle be operated in quick jerks and allowed to return to the mid-position, which it will do by spring pressure, until sufficient brake is obtained. After the airplane is stopped the brake may be released by pushing the handle to the full down position. There is only sufficient air for two complete brake actions if used with great discretion, so do not expect to put on all the pressure available the first time,then release it, and still have full brake action available for another time. If the first application is carried to the full pressure available (much more than is required for full brake action), the second application will only be to about half brake which should be sufficient to stop the airplane if it is going slowly. The system is set up this way because if more air were made available it would be possible to apply more pressure to the brakes than they could stand. This is an emergency system and it is felt that one stop followed by a release (to permit taxying off the runway), and another stop from slow taxying speed, should be enough for emergency conditions. A single line goes from the valve back along the left side of the navigator's compartment to a position under the rear navigator's seat where a tee with branches to either side is installed. It seems almost foolish to point out that after using this system the brakes must be thoroughly bled before normal operation can be obtained.

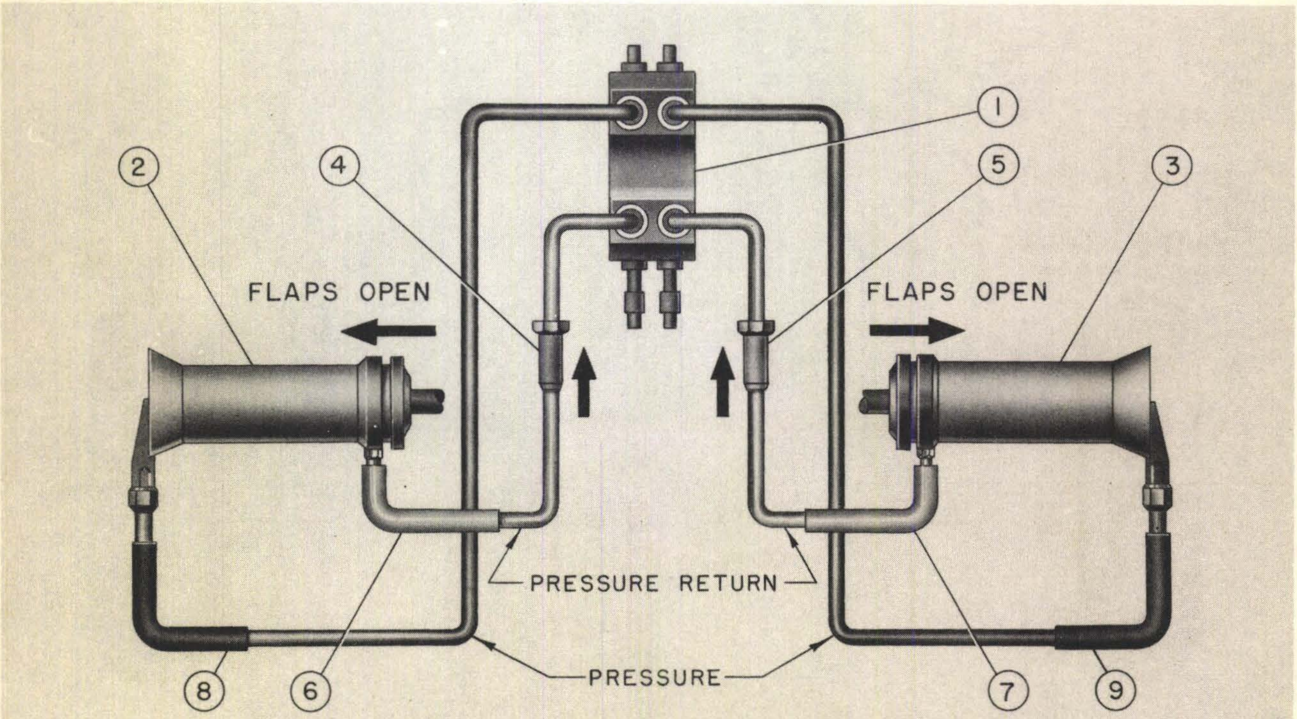


FIG. 31 ENGINE COWL FLAPS SYSTEM

NOMENCLATURE - HYDRAULIC SYSTEM LINES DIAGRAM

(Refer to N.A. Dwg. 62-58001)

ENGINE COWL FLAPS SYSTEM

1.	Valve - Engine Cowl Flap Position Selector	62-58011
2.	Strut - L.H.Engine Cowl Flap Operating	62-58035
3.	Strut - L.H.Engine Cowl Flap Operating	62-58035
4.	Valve - L.H.Open Pressure Line Restrictor	62-58084-5
5.	Valve - R.H.Open Press. Line Restrictor	62-58084-5
6.	Hose - L.H. Open Press. Line Flexible	39G1030-5-16
7.	Hose - R.H. Open Press. Line Flexible	39G1030-5-16
8.	Hose - L.H. Close Press. Line Flexible	39G1030-5-24
9.	Hose - R.H. Close Press. Line Flexible	39G1030-5-24

BOMB DOOR SYSTEM

1.	Valve - Bomb Compartment Door Position Selector	62-58016
2.	Strut - Bomb Compartment Door Operating	62-58037
3.	Valve - Bomb Compartment Door Open Press. Line Restrictor	62-58084-4

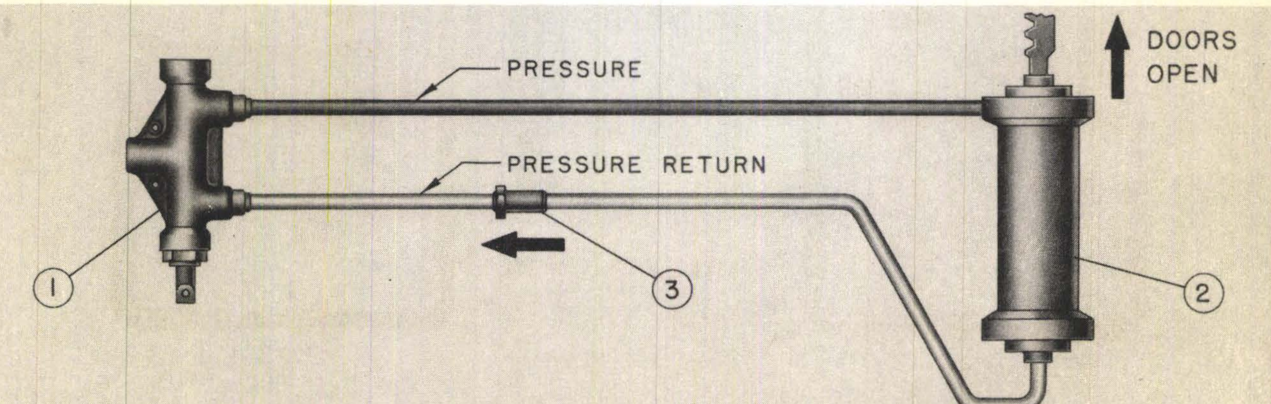


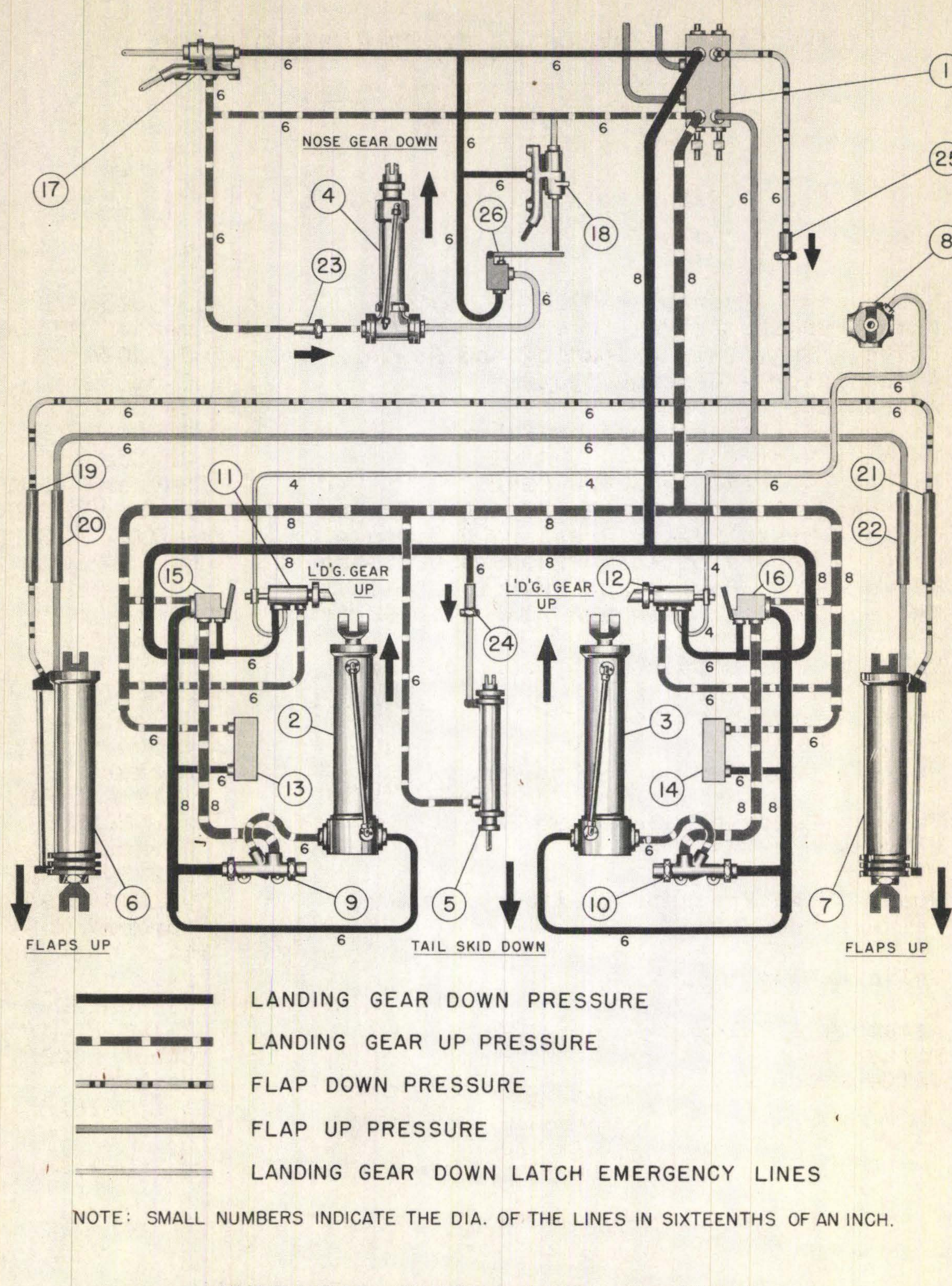
FIG. 32 BOMB DOOR SYSTEM

NOMENCLATURE - HYDRAULIC SYSTEM LINES DIAGRAM

LANDING GEAR AND WING FLAPS

(Refer to N. A. Dwg. 82-58001)

1.	Valve - Landing Gear and Wing Flap	62-58011
2.	Strut - L.H. Landing Gear Operating	62-58026
3.	Strut - R.H. Landing Gear Operating	62-58026
4.	Strut - Nose Gear Operating	62-58028
5.	Strut - Tail Skid Operating	62-58030
6.	Strut - L.H. Wing Flap Operating	62-58032
7.	Strut - R.H. Wing Flap Operating	62-58032
8.	Valve - Emergency Selector Valve	62A-58025
9.	Valve - L.H. Landing Gear Cross-Flow	62A-58072
10.	Valve - R.H. Landing Gear Cross-Flow	62A-58072
11.	Lock - L.H. Main Landing Gear Down Position	62-58092
12.	Lock - R.H. Main Landing Gear Down Position	62-58092
13.	Lock - L.H. Main Landing Gear Up Position	62-58093
14.	Lock - R.H. Main Landing Gear Up Position	62-58093
15.	Valve - L.H. Landing Gear Timing Valve	62-58067
16.	Valve - R.H. Landing Gear Timing Valve	62-58067
17.	Lock - Nose Gear Down Position	62-58029-2
18.	Lock - Nose Gear Up Position	62-58029-3
19.	Hose - L.H. Wing - Flap Down - Line Flexible	39G1030-6-16
20.	Hose - L.H. Wing - Flap Up - Line Flexible	39G1030-6-16
21.	Hose - R.H. Wing - Flap Down - Line Flexible	39G1030-6-16
22.	Hose - R.H. Wing - Flap Up - Line Flexible	39G1030-6-16
23.	Valve - Nose Wheel Restrictor	62-58084-3
24.	Valve - Tail Skid Restrictor	62-58084-2
25.	Valve - Wing Flap Restrictor	62-58084-6
26.	Valve - Hydraulic Nose Gear Up-Latch Timing	62-58065



HYDRAULIC SYSTEM LINES DIAGRAM

FIG. 33 (LANDING GEAR AND WING FLAPS)

NOMENCLATURE - HYDRAULIC SYSTEM LINES DIAGRAM

POWER LINES

(Refer to N.A. Dwg. 82-58001

1.	Reservoir - Hydraulic Oil	62-58051
2.	Pump - Engine Driven	"pesco" 203-AD
3.	Valve - Eng. Pump Unloading and Relief	62-58074
4.	Accumulator - General System	62-58376
5.	Accumulator - Brake	62-58376
6.	Valve - Brake Accumulator Exhaust	82-58089
7.	Valve - Restrictor	62-58083
8.	Snubber - Brake Pressure Gauge	"Parker" 4PSGGXX
9.	Snubber - General System Pressure Gauge	"Parker" 4PSGGXX
10.	Gauge - Brake System Pressure U.S.Gauge Co.	AW17/8-17-E
11.	Gauge - General System Pressure U.S.Gauge Co.	Type E-3
12.	Valve - Eng. Cowl Flaps Position Selector	62-58011
13.	Valve - Landing Gear and Wing Flap Position Selector	62-58011
14.	Valve - Bomb Compartment Door Position Selector	62-58016
15.	Valve - Brake "Vickers"	AA 13010
16.	Pump - Hand	62-58024
17.	Valve - One Way	"Parker" 11-1439-6-5D
18.	Valve - Emergency Selector	62A-58025
19.	Valve - One Way	"Parker" 11-2739-8-8D
20.	Hose - High Pressure Flexible	39G1030-6-24
21.	Valve - One Way	"Parker" 11-2739-8-8D
22.	Valve - Plug	"Parker" 702-FG-12D
23.	Assembly - Valve	475-GT-8D
24.	Filter	"Cuno" 10226
25.	Valve - One Way	"Parker" 11-839-18-8

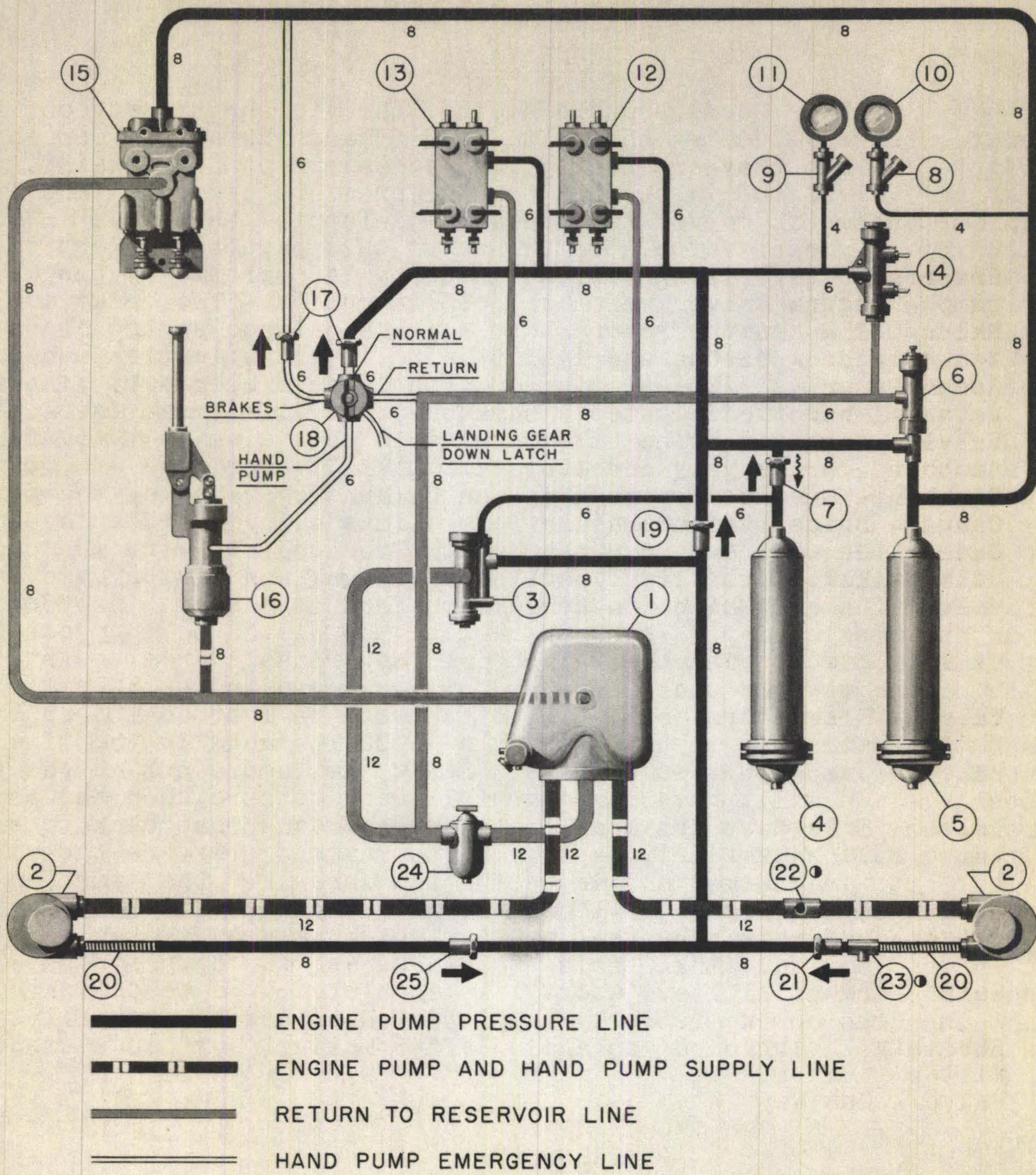


FIG. 34 HYDRAULIC SYSTEM LINES DIAGRAM (POWER LINES SYSTEM)

ADDENDUM I

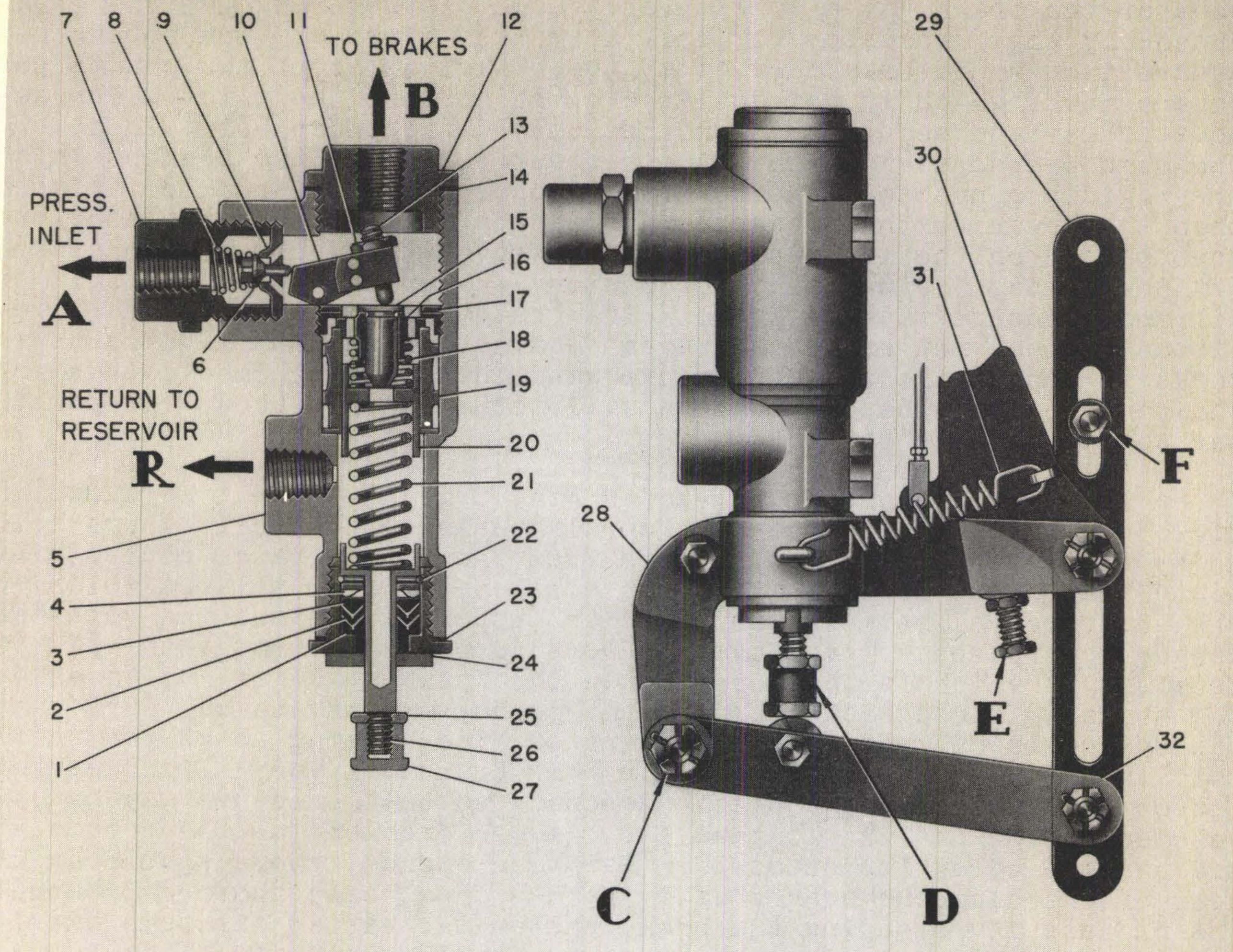
Items peculiar to B-25, B-25A and B-25B airplanes only.

1. BRAKE VALVE

You may have some trouble seeing the similarity between the schematic brake valve we showed in Fig. 13 and the actual one shown in Figure 35, but they are really just alike except for details. In the actual valve the inlet port for the pressure is port A and just as in our schematic valve, the pressure inlet to the valve is controlled by a poppet valve. In the valve this poppet is very small and is operated by linkage which, in turn, is operated by the movement of the return valve which slides in guides. The brake outlet is marked port B and the return port R. The balance spring bears against the sliding piston and against a follower which is pushed to "turn on" the valve. The sliding piston is an exceedingly fine fit in its barrel and the slightest scratch on it will make the action of the valve erratic. The only packing in the valve is that around the stem, and it is very doubtful if it will ever need to be replaced. If it must be replaced it can be done by removing the pivot bolt C which holds the operating lever, thus allowing the lever to drop out of the way, and then taking out the end nut with the packing. That will let the stem, packing, springs, and piston come out. The acorn nut D will have to be removed from the stem in order to put in the new packing. When you replace the piston be very careful that it is replaced with the valve seat upward as the valve sets in the ship, and be sure that it is properly entered in the barrel. The adjustment of the acorn nut will, of course, be lost so it must be reset. To do this it is well to put a 1000 lb. gage in the line to the debooster and apply some brake. Screw the acorn nut out as far as possible and still have the gage fall back to zero when the pedal is released. This does not mean that the gage can creep back to zero -- it must fall back fairly rapidly. The maximum pressure the valve will put out is changed by adjusting the screw E. The farther in this is turned the higher will be the output pressure. The parking pressure is adjusted by the bolt F which clamps a stop in the slot in the vertical link. This should be as far down in the slot as possible and still leave about 1/16 inch clearance to the parking latch when the brake is fully applied. Needless to say all lock nuts should be tightened up again after making any adjustments.

2. DEBOOSTER

In the B-25, B-25A and B-25B airplanes, the output of the brake valve is connected to a Debooster which in turn connects to the brake. This is necessary because the type of brake used on the B-25 operates at such a low pressure that smooth control is not possible over such a small range for direct control. If the valve were connected directly to the brake and the valve should make an error of ten pounds per square inch in what it put out, there would be a very large



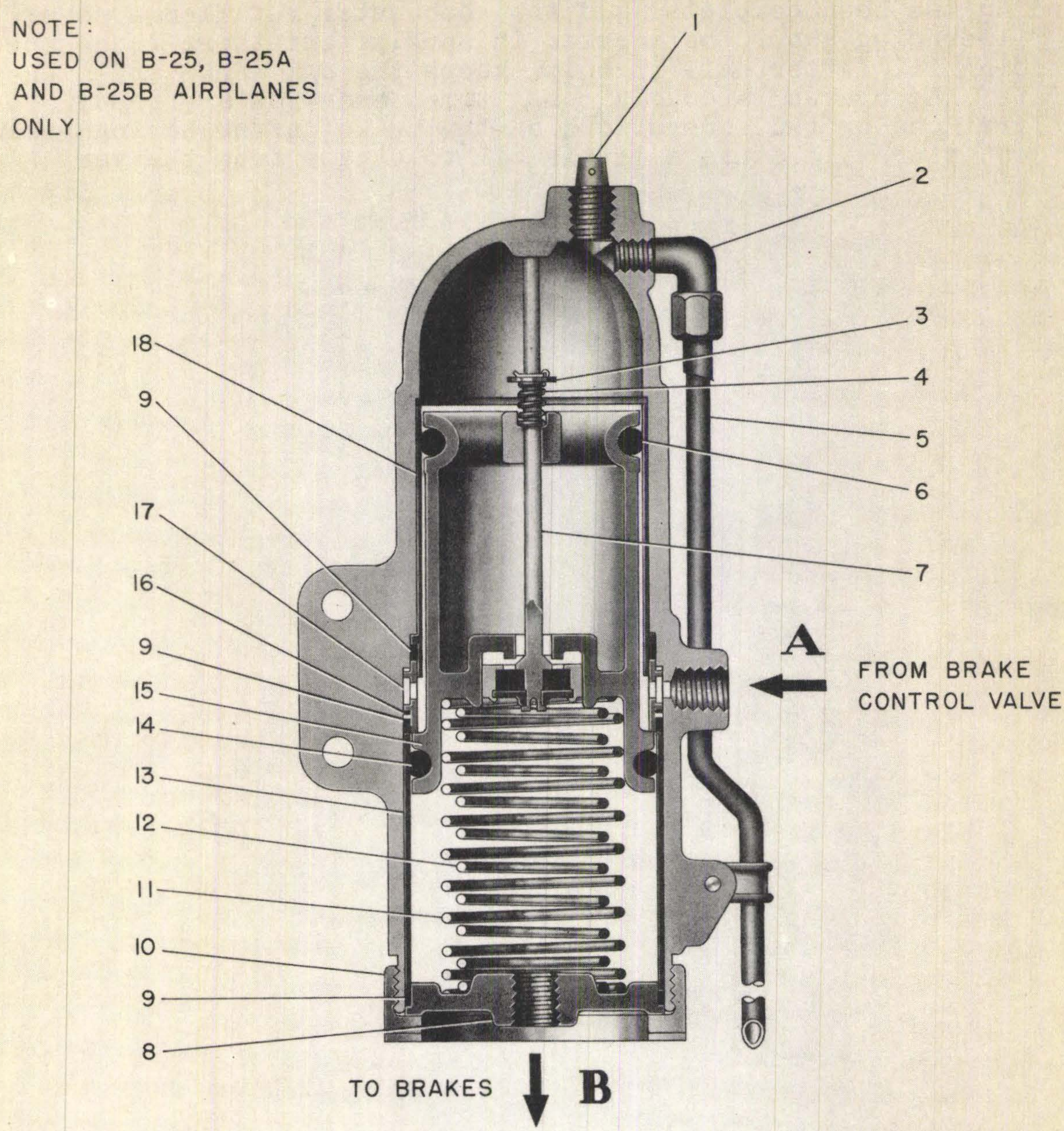
1.	RING-BASE	12.	CAP-HOUSING END	23.	WASHER
2.	RINGS-PACKING	13.	SCREW-ADJUSTING	24.	NUT-PACKING RETAINER
3.	RING-CAP	14.	WASHER-SEALING	25.	NUT-LOCK
4.	SPACER-PACKING	15.	VALVE	26.	ROD-PUSH
5.	HOUSING	16.	GUIDE-VALVE	27.	NUT-SPECIAL
6.	VALVE-INLET	17.	NUT-VALVE RETAINER	28.	FITTING
7.	CAP-INLET	18.	SPRING-VALVE	29.	LINK
8.	SPRING-INLET VALVE	19.	GUIDE-VALVE SEAT	30.	FORK
9.	SEAT-VALVE	20.	SEAT-VALVE	31.	SPRING
10.	ASSEMBLY-CAM LEVER	21.	SPRING	32.	ARM
11.	NUT-MACHINE SCREW	22.	RING-PACKING RETAINER		

62-58078

FIG. 35 BRAKE VALVE

error in the amount of brake action produced. By using the debooster the brake valve works over a much larger range which is reduced by the debooster so that a valve error of ten pounds per square inch would only show up at the brakes as about two pounds per square inch, which is not so large as to disturb the pilot. The debooster is made about as shown, the only differences being in detail. The high pressures come into the debooster between two pistons which are rigidly connected together. The upper piston is smaller in area than the lower so the pressure pushes up on the upper piston but down harder on the lower piston which moves the whole piston assembly downwards. Below the lower piston is a chamber which is full of oil and connects to the brake. The ratio of the area of the lower piston to the net effective area against which the high pressure works is about five to one; so we see that five hundred pounds per square inch from the brake valve will actually put about 100 pounds per sq. in. on the brake.

The Brake Debooster Valve (N.A.A. Dwg. 62-58079) is shown in Fig. 36. It consists of a cast dural housing with steel liners held in by the lower cap nut. The line from the brake valve connects at port B, and the pressure it brings acts on the annular area which is the difference between the smaller upper area and the somewhat larger lower area. The brake connects to port A. Through the piston is a valve which is held open when the piston is full up to allow the brake to bleed back through the debooster and to be sure that the system is full of oil. The part of the housing above the cross wall in the piston is a reservoir for fluid. A very light spring closes this valve as the piston descends so that pressure may be developed below it. So long as the oil is checked in the debooster and no line below the debooster has been opened, there should be no need of bleeding the brakes after it has once been thoroughly done. The process of bleeding the brake system is rather tiresome but it is necessary if a line has been opened so that air might get in. To bleed the high pressure side of the debooster is easy--simply open the bleeder connection in the tee where the high pressure line connects and hold the brake pedals part way down. Of course it is necessary that there be some source of power on the system, and the usual method of attaching a bleeder hose with the end below the surface of some oil in a container is advisable. Don't push the brake pedals too far down or it will blow the bleeder hose out. The brakes themselves must be bled in quite the usual way. The bleeder hose should be connected and the brakes operated slowly until no more air is discharged. Of course it is necessary to keep the debooster full of oil while bleeding the brakes, and both inboard and outboard brakes must be bled separately. It is well to put a piece of copper tubing against the top of the piston wall through the filler when bleeding the brakes, so that the movement of the piston may be checked. It occasionally happens that the piston does not come fully up every time while bleeding the brakes especially if the work is hurried. If this happens operate the brake pedals a few times slowly and check again. If it still does not work the central valve in the piston may be pushed down gently with a bent piece of metal. This is not a condition which often occurs, as it never happens except when the fluid in the brake and in the debooster just



1. PLUG
2. ELBOW
3. SEAT
4. SPRING-(SEAT)
5. VENT LINE
6. RING-PACKING
7. ASSEMBLY-STEM
8. RETAINER
9. GASKET
10. END
11. SPRING-PISTON OUTER
12. SPRING-PISTON INNER
13. SLEEVE-OUTER
14. RING-PACKING
15. PISTON
16. SPACER
17. SPACER
18. SLEEVE-INNER

62-58079

FIG. 36 BRAKE PRESSURE DEBOOSTER VALVE

happen to trap a bubble of air in the wrong place while bleeding. After the air has all been bled out such a thing cannot happen. When bleeding has been completed and the debooster refilled to overflow, the filler plug should be screwed in snugly but there is no need of overdoing it. After all it only keeps the oil from spilling out. Operate the brakes a couple more times and you are ready to go. The first one or two operations of the brake after having refilled the debooster will cause a little oil to escape from the vent.

BOMB
INSTALLATION

NORTH AMERICAN AVIATION Inc.

Bomb Install. LECTURE

B-25 SERIES AIRPLANES

PREPARED BY Geo. H Bentley

NOTE

THE INFORMATION CONTAINED IN THIS LECTURE WAS CORRECT AS OF MAY 15, 1942. REFER TO HANDBOOK OF OPERATION AND SERVICE INSTRUCTIONS FOR THE LATEST INFORMATION.

N A A

INGLEWOOD, CALIFORNIA

INDEX

I L L U S T R A T I O N S

BOMB RACKS GENERAL

Bomb racks in the B-25C and B-25D airplanes are manually controlled and electrically operated. The electrical control releases the bombs in the selected or trained release. The manual control is for locking and salvoing of the racks. The pilot's emergency release is also a manual operation.

In the bombardier's compartment there is a control unit consisting of a single handle in a housing with an etched cover plate which indicates the different positions of the control handle. This handle controls the bomb doors as well as the bomb racks. The extreme aft position is "DOORS CLOSED RACK LOCKED". The next forward position is "DOORS OPEN RACK LOCKED". The position forward of this is doors open and rack in "SELECTIVE" position ready for electrical release. The extreme forward position of the handle is for "SALVO". Before this can be accomplished, it is necessary to raise out of the path of travel of the control handle a guard which is there to prevent accidental salvo of the racks. This guard, when raised, will permit the handle to be pushed into the salvo position, thus, releasing all the bombs on the racks.

BOMB RACK CONTROLS

A control cable (one-sixteenth (1/16) inch diameter corrosive resistant, extra-flexible, steel cable) links the drum at the fulcrum point of the control handle in the bombardier's compartment to the sector (3) which is forward of the pilot's emergency unit (5). An adjustable push-pull rod (4) links the sector and the forward end of the strut on the pilot's emergency unit (5). An adjustable push-pull rod (6) connects the aft end of the strut assembly on the pilot's emergency unit (5) to a bellcrank assembly (7). An adjustable push-pull rod (8) attaches the bellcrank assembly (7) to the cam and sector assembly (9). A cable (10) ties the cam and sector assembly (9) to the bomb door safety lock and sector (11). A push-pull rod (12) connects the bomb door safety lock and sector (11) to a bellcrank (13) on the forward side of the right-hand rack assembly (14). A vertical push-pull rod (15) travels from the bellcrank (13) up the rack (14) to an idler (16).

There are two adjustable push-pull rods taken off the idler (16). The outboard adjustable push-pull rod (17) connects the idler (16) to a vertical bellcrank (18) to which another adjustable push-pull rod (19) connects to the bellcrank assembly (20) on the top spacer assembly (21). Another adjustable push-pull rod (22) takes off the bellcrank assembly (20) and connects to the lock and salvo channel (23).

A vertical, adjustable push-pull rod (24) connects the idler (16) to a vertical, adjustable bellcrank (25). An adjustable push-pull rod (26) links together the horizontal bellcrank (27) and vertical bellcrank (25) which control the two racks (14) and (32). An adjustable push-pull rod (28) connects from the bellcrank assem-

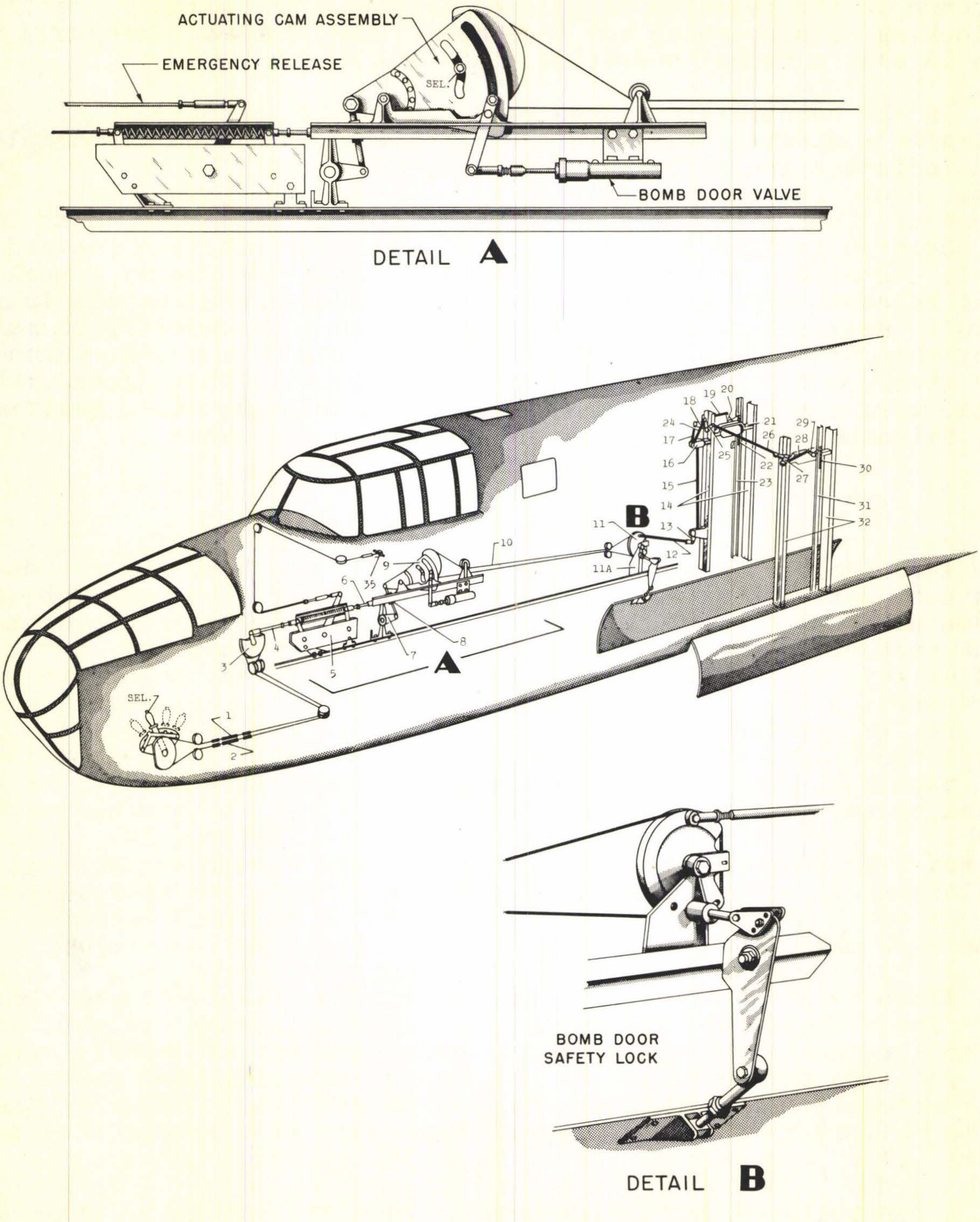


FIG. 1 SCHEMATIC DIAGRAM OF BOMB CONTROLS
(B-25C AND B-25D)

bly (27) to a bellcrank (29) mounted on the top spacer assembly of rack assembly (32). An adjustable push-pull rod (30) ties the bellcrank (29) to the salvo channel (31).

RIGGING CONTROLS

The following procedure is recommended for rigging the bomb rack and bomb bay door controls:

General Data:

The maximum turnbuckle adjustment tolerance is four threads exposed. Safety all turnbuckles with six (6) to eight (8) turns of brass or stainless steel wire at each end of the turnbuckle barrel. Adjustable push-pull rods are provided with a safety hole in the ball bearing rod end. The threaded stud entering these rod ends must pass the safety hole to maintain the proper thread safety factor.

All cables in the bomb control system should be adjusted to seventy (70) pounds cable tension. Cable loads should prevail when the temperature is at seventy (70) degrees F. plus or minus five (5) degrees F. (twenty-one (21) degrees C. plus or minus three (3) degrees C.). This tension will cover a one hundred (100) degree F. temperature range, which is all that the airplane should encounter since the cable controls are in the heated portion of the ship.

Method For Rigging:

To rig the cable controls on the B-25C and subsequent airplanes, the following procedure is recommended:

1. Place the bomb control handle in the bombardier's compartment in the "SELECTIVE" position.

2. Adjust turnbuckles (1) and (2),(one under the bombardier's riding seat and the other under the cover plate directly aft of the bomb control handle) to obtain proper cable tension. The bellcrank (3) on the outboard side of the sector and bellcrank assembly mounted on the right-hand side of the airplane just forward of the bombardier's rear section bulkhead, shall be set at eight and one-half (8-1/2) degrees forward of the vertical position or four and five-sixteenths (4-5/16) inches from centerline of hole in arm for rod end on sector to face of station seventy (70). This is the "SELECTIVE" position for the bellcrank (3) and is adjusted by the two turnbuckles.

3. Move the bomb release handle to the "DOORS CLOSED" position. Check the pilot's emergency release unit (5) to make sure

it is cocked. Adjust the push-pull rod (4) from the sector and bellcrank assembly to the release unit (5) so that the aft arm just touches the aft stop inside the unit. Do not release the unit until all controls are complete.

4. Set the bomb control handle to the "SALVO" position and adjust the bellcrank (7) by lengthening or shortening it's push-pull rod so that it clears the fuselage bulkhead by one-sixteenth (1/16) to one-eighth (1/8) of an inch.

5. Place the bomb control handle in the "SELECTIVE" position. The actuating cam assembly (9) mounted in the nose wheel well shall be adjusted to the "SELECTIVE" position also. The cam roller that operates the bomb rack controls shall be centered to the position marked "SEL" stamped on the face of the cam. This adjustment must be made to obtain the proper travel of the controls.

6. The bomb door safety lock assembly, located on the right-hand side of the airplane in the bomb bay, has an aligning hole through the mounting bracket (11A). The sector (11) has a similar aligning hole. These holes are to be rigged to coincide in the "SELECTIVE" position so that a pin can be inserted in them to insure perfect alignment. Remove the pin after alignment.

7. The bombardier's control handle shall now be moved to the "DOORS OPEN RACKS LOCKED" position. The push-pull rod (12) from the bomb door safety lock to the right-hand bomb rack assembly is to be disconnected to allow the lock-salvo channel assemblies on both left and right-hand bomb racks to drop down to the locked position. A check shall be made to insure that both channel assemblies are resting at the top of the cam path in all bomb stations. If one side should be up, adjust the connecting rod (26) across ship to permit both channels to drop down into the locked position.

8. Check the salvo position of each rack by reversing the procedure. If salvo does not occur simultaneously in both racks, adjustment can be accomplished by an adjustable bellcrank (25) at the top of the right-hand rack. The bomb racks can thus be synchronized by checking the lock and salvo positions.

   Reassemble the push-pull rod (12) from the bomb rack to the bomb door safety lock, adjusting it to its proper length.

9. A check shall now be made to see if the bomb racks will manually salvo from the bombardier's control handle. If the control handle fails to release all stations, the rod (12) from the safety lock to rack should be shortened. When the salvo control is satisfactory, cock all stations

and put the control handle in the "DOORS OPEN - RACKS LOCKED" position and try to release with a screw driver. A release check screw with an arrow indicating in which direction to turn to release, has been provided on the A-2 Release Assembly (34). No station should fire in Lock position.

10. The pilot's emergency release (5) should be tested. Hydraulic pressure not less than eight hundred (800) pounds should be provided in the accumulator. To operate the pilot's emergency release, it is necessary to remove the safety spring over the handle (35) and give one pull, out as far as it goes (the travel being about four (4) inches). This operation will first open the doors then release all stations on both bomb racks.

    Further adjustment on the rod (12) from the bomb door safety lock to the bomb rack may be necessary.

BOMB BAY FUEL TANK RELEASE MECHANISM

To adjust fuel tank release mechanism:

1. Place bomb controls in the "SELECTIVE" position.
2. The one-eighth (1/8) inch diameter aligning hole in the side plates of the release unit shall be in line with the aligning holes in the fork.
3. Make adjustment on either end of push-pull rod connecting the release unit to the bomb rack proper.

When this adjustment is properly made, the release unit will release simultaneously with the bomb rack shackle hooks.

RELEASE UNIT

The type A-2 release units are removable and need only be carried or installed when a bomb is carried on that particular station. The manner in which the rack is electrically wired provides a skip station feature.

Each station has an auxiliary switch box mounted on the rear face of the spacer assembly as shown on Figure 2. The switch button protrudes through the face of the spacer and when the release unit has been mounted makes contact for that position and will not fire or release another station until that station has been released. Therefore, to release a spare release unit in place would necessitate

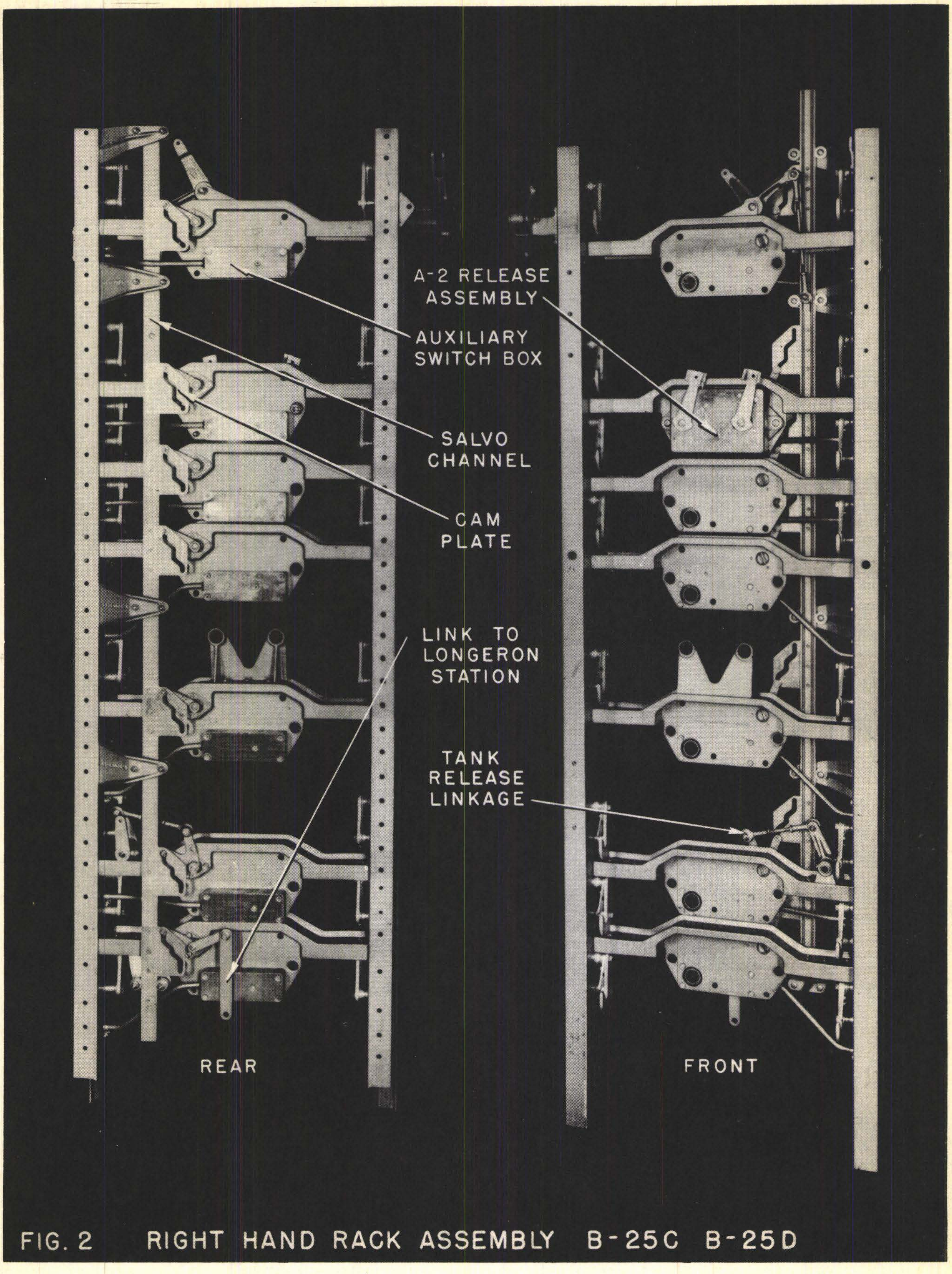


FIG. 2 RIGHT HAND RACK ASSEMBLY B-25C B-25D

the firing of a vacant position. The order in which the stations are released are as follows:

> The left-hand rack first releases the lower station known as #1, then the lowest station on the right-hand rack, known as #2, is released, the balance of the rack will then release in sequence from left to right up the rack. The positions or stations are stenciled on the face of the spacer assembly for identification.

LOCK AND SALVO

The lock and salvo is a manual operation, and is operated from the bombardier's control handle or pilot's emergency release handle.

The lock and salvo channel assembly, Fig. 2, is a series of cam plates mounted on a vertical bar. The travel of the channel to the down position will lock the racks. The upward motion of this channel is for salvoing the bombs. The cams are spaced so as to provide a time element between each station except the auxiliary stations 1A, 2A, 7A and 8A which will operate the same time as stations 1, 2, 7 and 8. This will allow the lower bomb to clear the rack before the next higher one is released, thereby preventing bombs from bumping when salvoing.

The synchronizing of the lock and salvo control is accomplished as described under Rigging Controls and shown on Figure 1.

ACTUATING CAM

The actuating cam was designed to eliminate a separate set of controls for the operation of the bomb bay doors. Both the bomb bay door cylinders in the rack controls operate from this actuating cam.

The adjustment of the cam is covered under Rigging Controls and shown on Figure 1.

BOMB RACKS

The bomb racks, Fig. 2, are the conventional, two-rail and spacer assembly, using the standard Army hook and latch assemblies, although the working portion or release unit of the rack will be the Hooven type as manufactured by P. R. Mallory & Co., Army designation 41G1742, type A-2.

The arming of this unit is automatically accomplished in the electric release condition. Before the shackle can be tripped, the arming lever is automatically thrown to arm before the release arm is free to trip. In manual control, however, it will salvo or emergency release bombs in the safe condition only.

PILOT'S EMERGENCY RELEASE

Pilot's emergency release handle is located on the pilot's instrument panel. This handle has a safety spring so that it will not accidentally be pulled. In order for the pilot to use this unit it is necessary for him to lift up on the spring lock and pull the handle straight aft approximately four (4) inches. This automatically opens the doors and releases the bombs in the safe condition.

To re-cock the emergency release in flight (this must be accomplished in the bombardier's compartment through the bomb rack control handle), the guard that prevents accidental salvo, shall first be raised out of the path of the handle. The control handle is then pushed into the extreme forward position and then brought back to doors closed position. This re-cocks the emergency release and closes the bomb bay doors at the same time.

TWO THOUSAND (2000) POUND BOMB RACK

The two thousand (2000) pound bomb rack, Fig. 3, is a rigid, sheet metal structure which bolts to the bomb rails with seven-sixteenths (7/16) inch diameter Allen socket head screws. The proper procedure for installation is as follows:

1. Loosen the eight (8) one-fourth (1/4) inch bolts, four of which are on the top web near the center of the beam, and the other four on the bottom flange near the center beam. These bolts are used to make adjustments to accommodate the variations in width between the bomb rails on the various airplanes.

2. Retract the telescopic control tubes by locking their bayonet locks.

3. Lift two thousand (2000) pound bomb rack in place and insert and tighten the four (4) seven-sixteenths (7/16) inch Allen socket head screws. These screws secure the rack to the bomb rails.

4. Tighten the eight (8) one-fourth (1/4) inch adjusting screws. The two thousand (2000) pound bomb rack now rests in place, and is ready for the two thousand (2000) pound bomb to be hoisted in place.

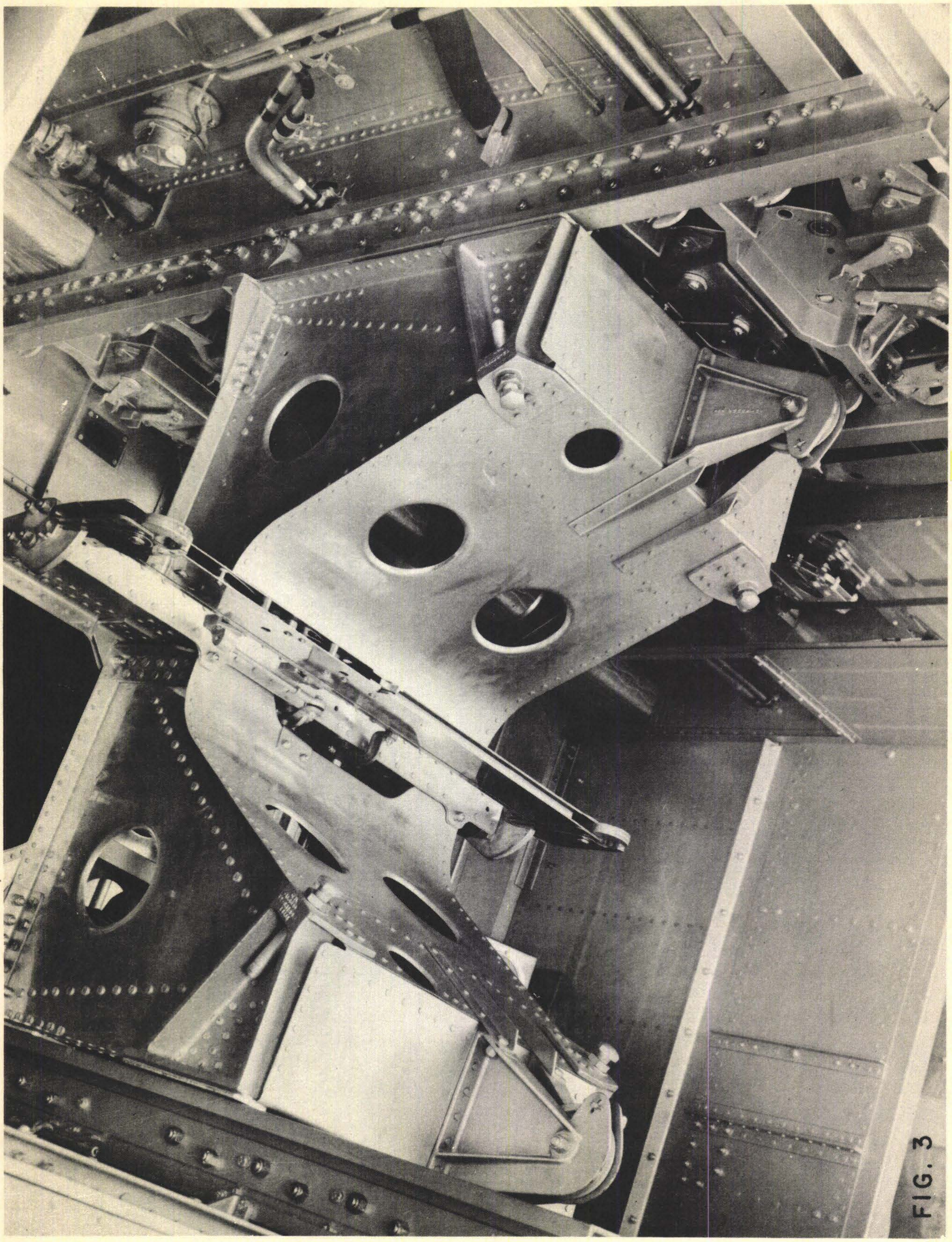


FIG. 3

There are two (2) control rods that operate the two thousand (2000) pound bomb rack. When in use they extend to a position where two (2) levers, one on either rod, engage with the operating dogs at the conventional bomb racks. The arm and safe dog operates the arm and safe lever of the two thousand (2000) pound bomb shackle, and the release dog operates the release lever of the two thousand (2000) pound bomb shackle. It should be kept in mind that these tubes are to be telescoped or disconnected from the operating dogs until the two thousand (2000) pound bomb is in place and the sway braces are tightened. Insofar as other bombs are not carried when the two thousand (2000) pound bomb is carried, the bomb rack can be cocked previous to hoisting the two thousand (2000) pound bomb.

LOADING AND HOISTING BOMBS

Loading One Hundred (100) Pound Bombs: It is much faster to load one hundred (100) pound bombs by hand than with the hoist unit, although provisions have been made for hoisting with the unit. By loading the lower stations first and progressing up the rack on both sides, hand loading is quite easily accomplished.

To Hoist Three Hundred (300) Pound Bombs: Before threading cable, remove A-2 release units from stations one (1) and (2). Thread cable as indicated in Figure 4, placing snatch block on stud for three hundred (300) pound bombs.

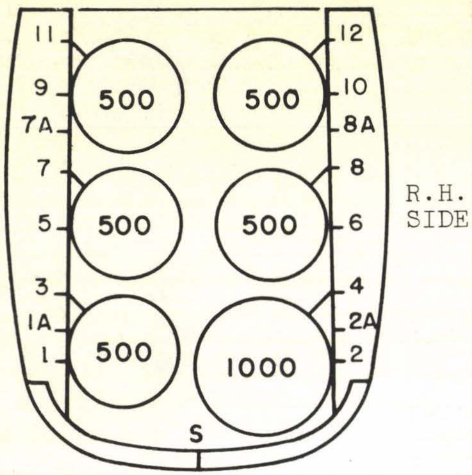
To Hoist Five Hundred (500) Pound Bombs: Before threading cable, remove A-2 release units from stations one (1) and two (2). Thread cable as indicated in Figure 4, placing snatch block on stud for five hundred (500) pound bombs.

To Hoist One Thousand (1000) Pound Bombs: Before threading cable, remove A-2 release units from stations one (1) and two (2). Thread cable as indicated in Figure 5, placing snatch block on stud for one thousand (1000) pound bombs.

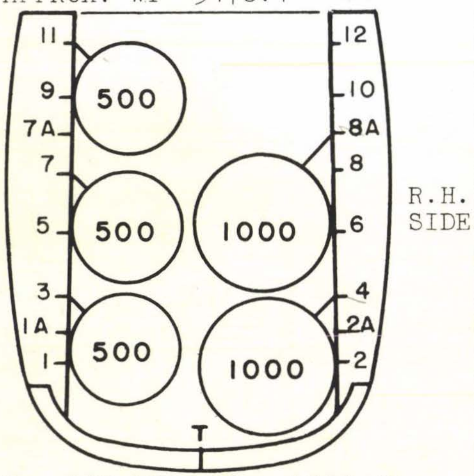
To Hoist Two Thousand (2000) Pound Bomb: (1) Make sure the two thousand (2000) pound bomb rack is securely fastened in place. (2) Retract the control rods and cock the bomb station #6, which operates the control rods.

A type D6 shackle should then be hung on the two thousand (2000) pound bomb rack, insuring that the latches have locked the shackle in place. An adjustment is provided on the lever arm of the control rods for adjusting the bomb shackle arming and release levers. The shackle has the word "FRONT" marked on the side to indicate which end is forward.

Place the two (2) hoist assemblies, Fig. 4, type C-3, in the key hole slots provided in the side of the fuselage, one on the right and the other on the left side of the airplane immediately above the bomb doors. Thread the hoisting cables through the opening adjacent to the hoist and under pulleys on the lower longerons, and



5 - 500 LB. 1 - 1000 LB.
APPROX. WT 3478.4



3 - 500 LB. 2 - 1000 LB.
APPROX WT. 3447.0

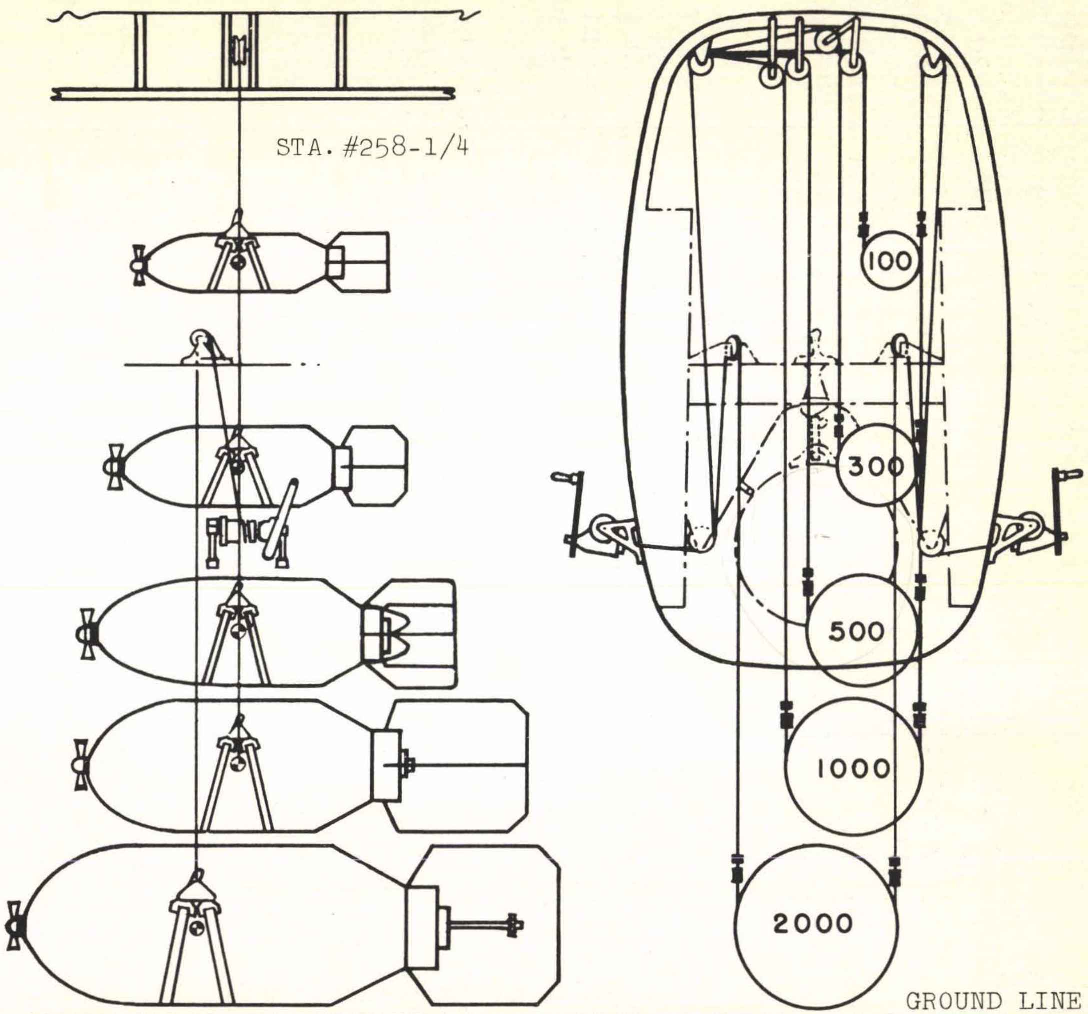
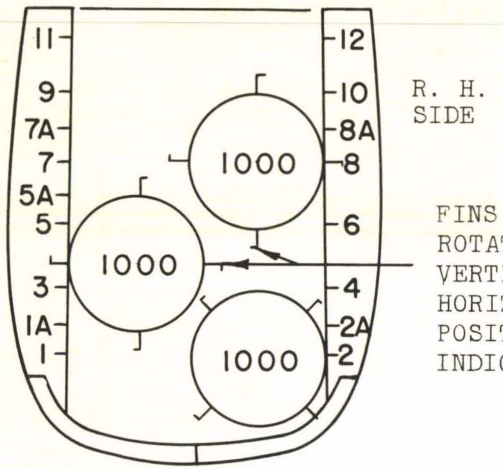
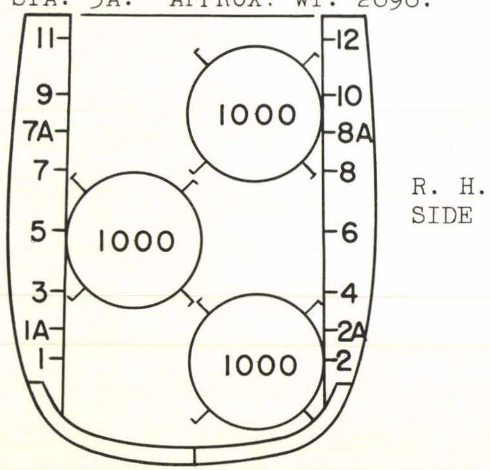


FIG. 4 OVERLOAD BOMB LOADING CHART

BOMB HOISTING CHART
(B-25C AND B-25D)

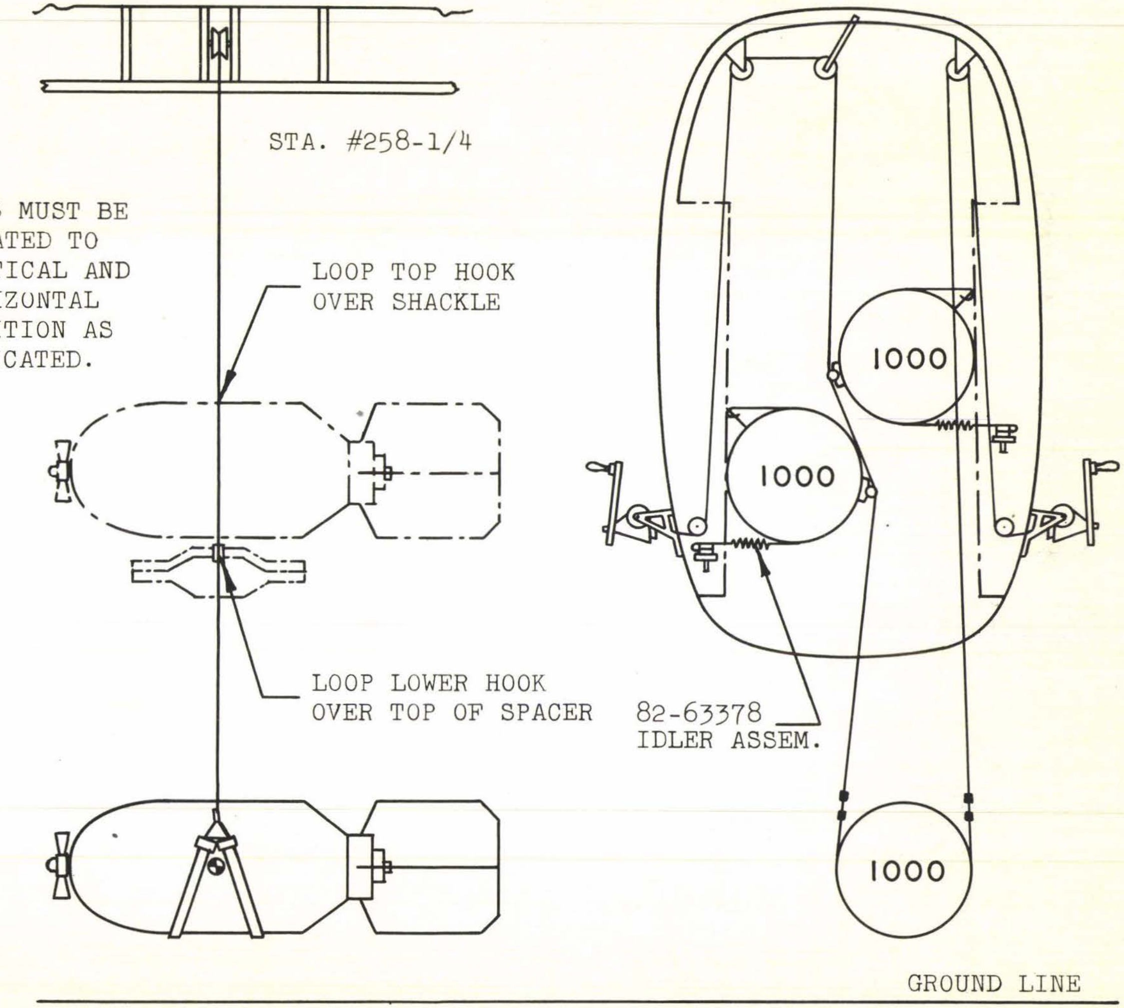


3-1000 LB. FOR ALL SHIPS WITH STA. 5A. APPROX. WT. 2898.



3-1000 LB. FOR ALL SHIPS MINUS STA. 5A. APPROX. WT. 2898.

FIG. 5 OVERLOAD BOMB LOADING CHART



BOMB HOISTING CHART 3-1000 LB. BOMBS (B-25C AND B-25D)

thence under the pulleys on the lower side of the two thousand (2000) pound bomb rack, from there the cable travels through the rack and over the pulleys on top of the two thousand (2000) pound bomb rack and then down to the two thousand (2000) pound bomb hoist sling.

After the bomb has been hoisted up to the shackle, make sure that the latch on the shackle has snapped in place. Insert the tube controls in the bracket on the side bomb rack assembly, insuring that the dogs or levers have entered the release unit lever. Once these tube controls have been adjusted on a two thousand (2000) pound bomb rack there should be no reason for re-adjusting the levers which control the two thousand (2000) pound bomb shackle even when bomb rack is installed in another airplane. The bomb is to be held in position with the hoist until all work of the loading personnel is completed, including the tightening of the four (4) sway braces.

After the two thousand (2000) pound bomb has been completely installed, a final check should be made to insure that all lever arms and sockets are firmly engaged.

CAUTIONS

When a bomb bay fuel tank is installed, extreme caution must be taken so as not to operate bomb control handles or the pilot's emergency release. The tank will be dropped in much the same manner as bombs, if the control handle is placed in salvo position, or the emergency release unit tripped.

In case of hydraulic failure and if it is desired to release bombs from the pilot's compartment, the bomb doors must be cranked open by the bomb door emergency operating crank. This is located in the navigator's compartment, Fig. 6, immediately aft of the entrance hatchway in the floor. The crank should be mounted on the shaft and cranked fast enough to keep the crank pressure on the doors as they lower. During this operation, the control handle in the bombardier's compartment should be in the "DOORS OPEN RACK LOCKED" position so that any pressure in the hydraulic cylinders or lines will not resist the opening of the bomb doors. After doors are opened by mechanical means as described above, the handle must be fastened to navigator's floor with strap provided, in order that doors will not tend to fly shut. The doors must be cranked open before the pilot pulls the emergency release handle. In case the pilot prematurely pulls the emergency release and the bomb racks fail to salvo, the emergency release unit must be re-set as described under Pilot's Emergency Release and again be released by the pilot. The bomb doors must be fully opened.

The bomb door safety lock pin must be properly adjusted to clear the bellcrank. It must be remembered that whenever the bomb doors are closed, the pin enters the hole in the bracket, therefore, it is necessary to have the bomb control rods hooked up when operating the doors. If for any reason the controls are not completely

rigged when closing the doors, caution must be taken to see that the bellcrank is clear of the pin, as a bent pin may result.

The airplane must not be flown with the bomb rail assemblies removed as they are considered a structural part, and are necessary to sustain some of the forces upon the ship in flight.

Under no condition is a lubricant to be used on any part of the bomb control system since cold weather tends to congeal the oil and slow up operation of the bomb rack, which would throw off the synchronization.

The bomb racks in these airplanes are simple yet sturdy, and they should require little servicing yet give service for a long period of time with proper adjustment and ordinary maintenance.

The rigging procedure as described above has been found to be the quickest and most satisfactory method of adjusting the bomb racks, but if for any reason the adjustments cannot be completed by following the foregoing procedure, all rods are adjustable so that additional adjustments can be made.

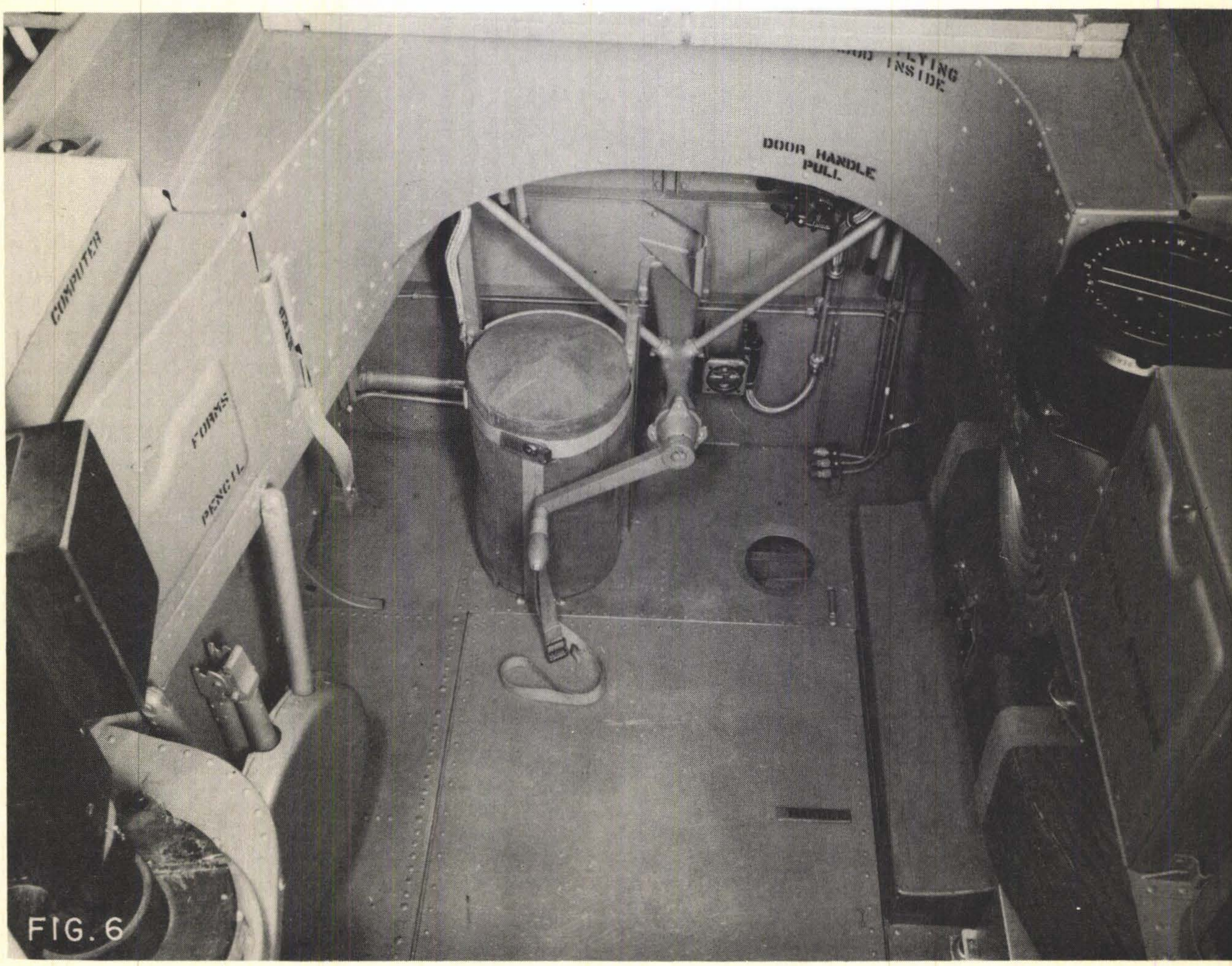


FIG. 6

ADDENDUM I

Items peculiar to B-25, B-25A and B-25B airplanes only.

BOMB RACKS GENERAL

Bomb racks in the B-25, B-25A and B-25B series airplanes are manually controlled, electrically and manually operated. The electric control releases bombs in selective or trained release; the manual control is for locking or salvo of the racks.

The bombardier's control handles are placed together in a unit and mounted to the left and below the bomb sight mount on the left-hand side of the airplane in the bombardier's compartment. The shorter handle is mounted outboard and is used to arm and safe bombs. The etched cover plate indicates the two positions, which are straight forward for the safe position and straight aft for the armed position.

The release control handle (A) is mounted slightly inboard of the arm and safe handle (B) and also has its positions indicated on the etched cover plate. Farthest aft position is Bomb Doors Closed. Just forward of that is the Bomb Doors Open, Racks Locked position. Farther forward is the Selective position and the extreme forward position is for Salvo.

Before entering the salvo position it is necessary to lift the safety stop latch, which has been incorporated in the control handle unit, so that it is impossible to salvo bombs accidentally. The bombardier can move the control handles to any position by depressing a plunger in the top of the handle then moving the control handle until a pawl drops into the proper notch.

Just aft of the control handle unit is an electric lock which is nothing more than an electric switch which cuts off all current going to the bomb racks when they are in an inactive position.

BOMB RACK CONTROLS

The bomb rack controls will be best understood if the reader follows the procedure beginning at the bombardier's control handles and tracing the linkages and units to the bomb racks. A schematic diagram, Fig.7, has been prepared, and by referring to this diagram, the reader may obtain a clear sequence of the operations.

Two control rods, (1) secured to the outboard arm-safe handle (B) and (2) secured to the inboard bomb release handle (A), continue aft and fasten to a double torque tube (3), one inside the other, which transfers their motions across the ship. From this point all bomb control units are mounted on the right-hand side of the airplane. Two bellcranks, (4) and (5), are attached at the right end of the torque tube (3). Control rods continue aft from here through station

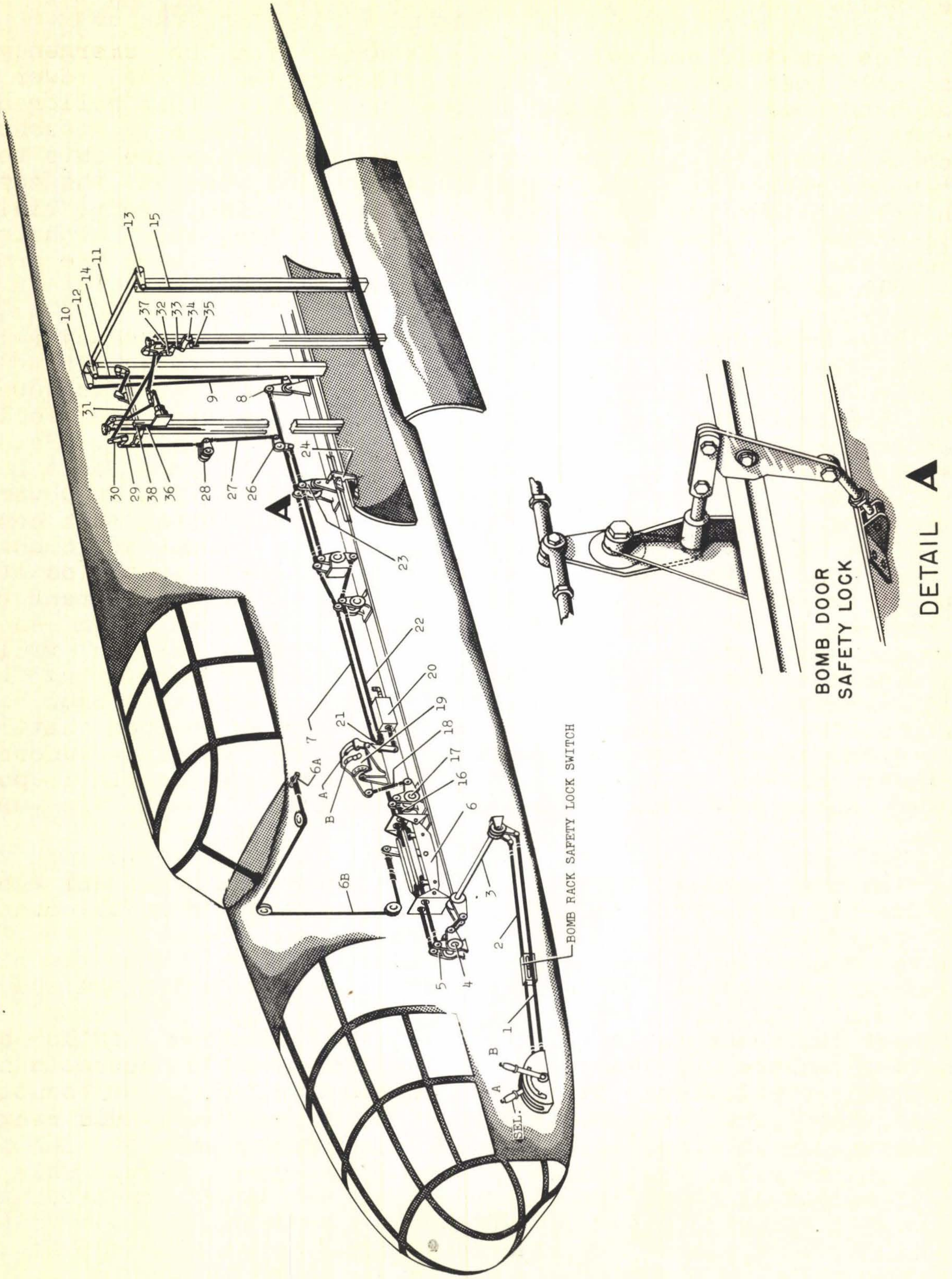


FIG. 7 SCHEMATIC DIAGRAM OF BOMB CONTROLS
(B-25, B-25A AND B-25B)

seventy (70) to the emergency release unit (6) located in the nose wheel well.

The arm-safe control rod (7) leading from the emergency release unit goes directly aft to a bellcrank (8) on the lower rear right-hand bomb rail. A control rod (9) connects this bellcrank to a lever (10) at the top of the same rail. This lever is attached to a torque tube (11) which transmits the motion across the ship to the left-hand rack. Two (2) levers, (12) and (13), one at the top of each rack, attach to the torque tube (11). Control rods, (14) and (15), attach to these levers and connect to rods, which actuate the arm and safe dogs at each bomb station. This completes the arm and safe control system.

The bomb release rod (16), after leaving the emergency release unit (6) connects to a bellcrank (17) which is connected with a control rod (18), to the bomb rack actuating cam (19). Two separate paths are provided on this cam. Path (A) operates the follower which actuates the bomb door hydraulic control valve (20). Path (B) is so formed in the cam to operate the follower from Racks Locked to Selective position and farther on to Salvo. The follower is connected to an outboard lever (21) to which is attached a control rod (22). The control rod (22) continues aft through bellcranks to the bomb door safety lock located at the forward right side of the bomb bay at the front hinge. The lock consists of a bellcrank (24), the bottom end of which is attached to the door as shown and the upper end has attached to it, a retrieving pin. The pin will act as a stop and prevent the motion of bellcrank (23) rotating which would actuate the bomb release lever and release the bomb. This safety device will insure that no bombs may be dropped until the bomb doors are in the extreme open position. When the doors are opened by the delayed action cam (19), the retrieving pin is pulled inboard and allows the bellcrank (23) to pass through its working arc.

The bomb release rod (22) continues aft to a bellcrank (26) at the lower front right-hand bomb rail. A control rod (27) connects this bellcrank to an idler (28). Another rod takes off the idler (28) and connects to an idler about a foot from the top of the right-hand rack. A control rod (29) takes off the outboard end and connects to a bellcrank (30) at the top of the right-hand rack. This bellcrank is connected with a control rod (31) to a similar bellcrank (32) on the left-hand rack. A control rod (33) connects bellcrank (32) to bellcrank (34) which is about a foot from the top of the left-hand rack. Two control rods (35) on the left-hand rack and (36) on the right-hand rack, attach the inboard ends of the bellcranks to the salvo channels (37) and (38) respectively. This completes the release, salvo and lock system.

FIRING SOLENOID

Since the racks, Fig.8, are electrically fired, a solenoid (39) has been mounted on the center line of the roof of the bomb bay. This solenoid is electrically energized through the intervalometer in the

bombardier's compartment. The solenoid actuates a bellcrank (40), and control rods (41) and (42) are connected to each side of the top of the racks. Kickers (43) and (44) are attached to the ends of the control rods as shown in the diagram, Fig. 8. The kickers, when actuated by the solenoid, fire the bomb stations alternately. This alternate firing is accomplished through ratchet discs (45) and (46) mounted at the top of each cam shaft (47) and (48). Each ratchet disc has six (6) slots cut into its circumference and are so synchronized that one of the kickers will raise the cam shaft while the other will pass through an opening. When the cam shaft is raised one bomb station will be fired. The vertical cam shafts (47) and (48) run the entire length of the bomb rail and are mounted on the forward side of each rack. Six (6) cams are mounted on each cam shaft, one for each bomb station. These cams are positioned fifty-six (56) degrees apart in rotation, so that in operation the lower bomb station is released first, the next above second and so on up the rack.

FIRING SYNCHRONIZATION

The cam shaft (47), Fig. 8, on the left bomb rack is interconnected with the cam shaft (48) on the right rack by means of a gear (52) and rack (53) and adjustable rod (54) assembly. The synchronizing rod (54) is adjustable and has a right and left-hand threaded section for adjustment. This assembly is indexed so that the lower station on the left-hand side releases first, the lower station on the right side second, the next to the lowest station on the left third and so alternately until all twelve stations are released. When the bomb rack is cocked, the cam shaft is rotated in reverse radially loading a spring so that the shaft will tend to return to its uncharged position. It cannot return, however, for the bottom cam (49) stops against the operating pawl (50) of the bottom cocked station and remains there until that station is fired. By this means selective release of bombs may be achieved at the bombardier's station. In train release, these operations can happen so close together that in about a second the entire rack is exhausted.

SALVO CHANNELS

The U-shaped, steel salvo channels, (37) and (38), Fig. 8, extend nearly the entire length of the bomb racks. A bolt and spacer assembly attached to each trigger pawl (50) extend through the elongated slots in the channel. The lengths of the slots vary, the shortest slot is located at the bottom station and each following slot above is a little longer. The tops of the channels are attached to the control rods (35) and (36) and from here by previous mentioned bellcranks, etc., to bombardier's release handle. In operation, when the bombardier moves his control handle (A) to SALVO position, the salvo channel moves upward picking up the bottom trigger pawl (50) first, and thus firing that station. Then the next slot above will pick up the next pawl and so on up the rack, firing all the stations in sequence. When the salvo channel is moved downward, the upper end of each slot stops against the spacer of each trigger pawl and prevents it from being lifted, thereby locking the rack.

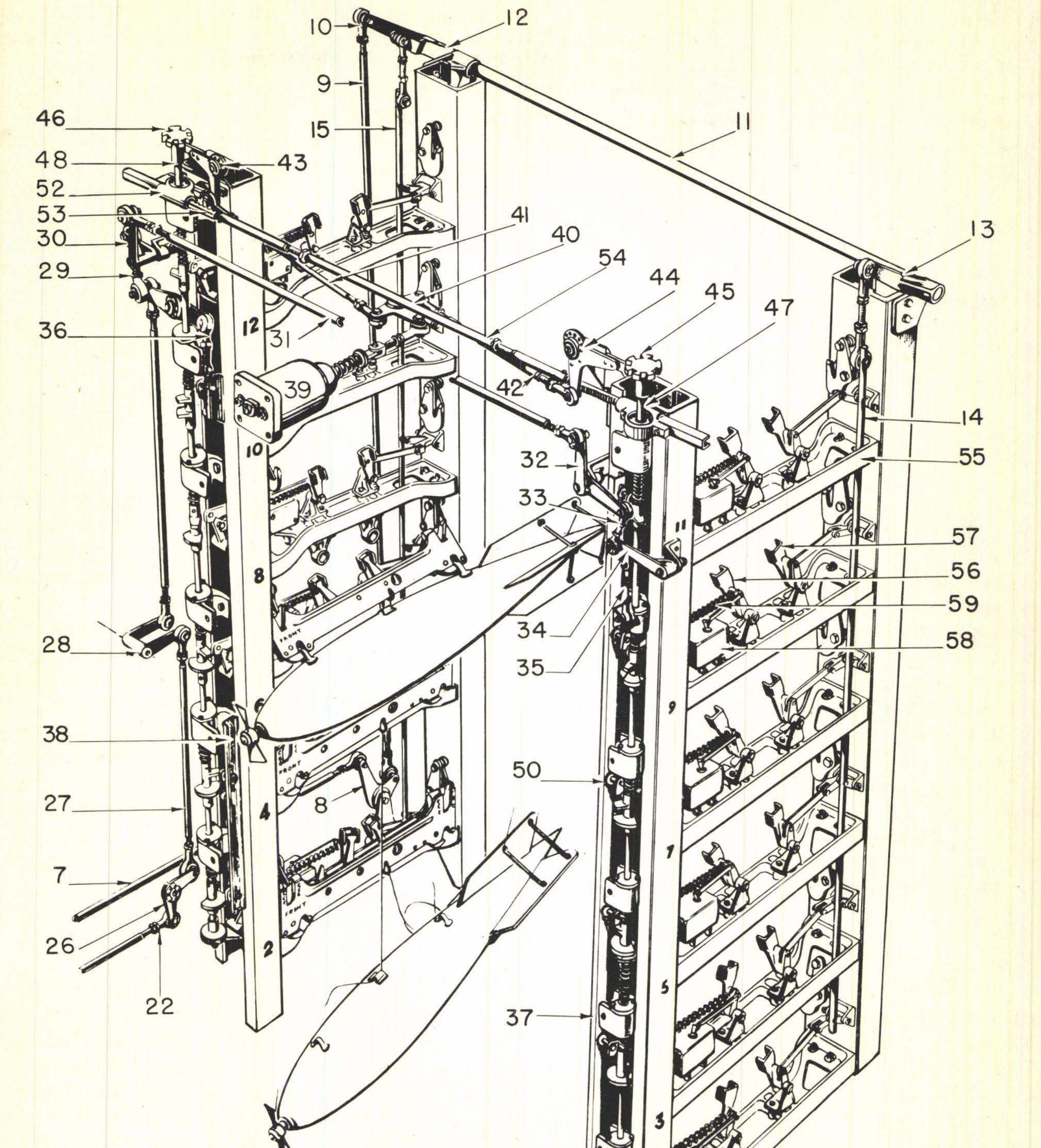


FIG. 8 RACK ASSEMBLY (B-25, B-25A AND B-25B)

CHARGING BOMB RACKS

A cam shaft charger handle is mounted just forward of the left bomb rack. It is intended that the hoist mechanic pull down on the handle with his right hand, and reach over and cock No. 1 bomb station with his left hand. After cocking the first station, the handle may be released and all other stations may be cocked without the use of this handle. The cam shaft charge mechanism consists of a cable and pulley arrangement which rotates the shafts (47) and (48) against their spring load in the required direction. Cocking the lower left bomb station holds the shaft in the energized position.

EMERGENCY RELEASE UNIT

The emergency release unit (6) is very similar in actions to a cut-out in an electric circuit. This unit is designed to perform the following duties:

1. To automatically safe the bomb if the bombardier should leave the control handle in the arm position.

2. To open the bomb doors.

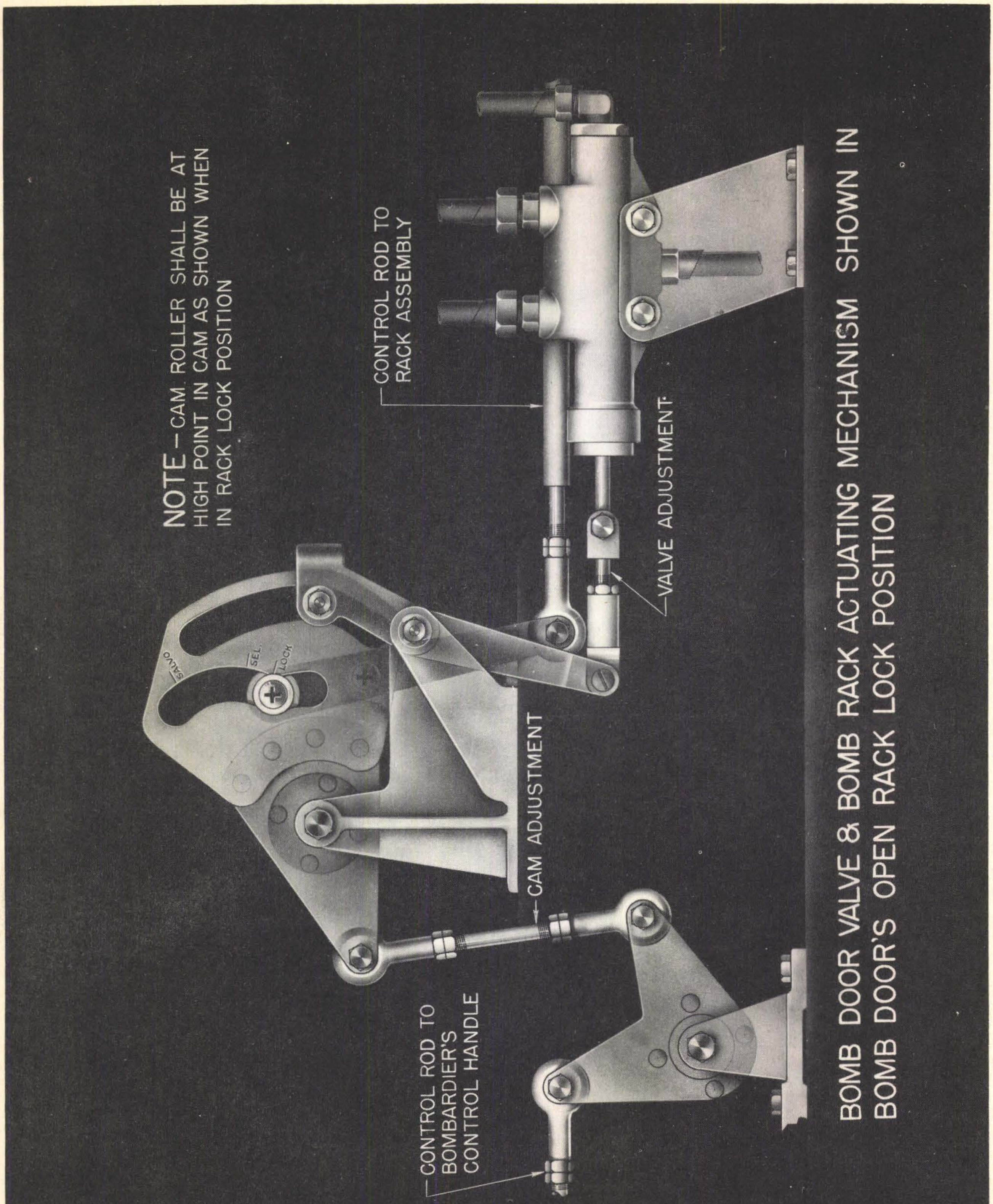
3. To trip the bomb racks.

These operations are done in sequence as outlined. The emergency release unit has two (2) struts which carry the action of the control rods straight through in normal operation. When releasing bombs in routine operation, the emergency release unit allows the action of the control rods to function unhampered. However, in case of an emergency, should it become necessary for the pilot to release all bombs from the bomb bay, he can disengage the spring safety guard of the emergency bomb release handle (6A) and pull the handle. The bomb doors will automatically and hydraulically open and the bombs will be released in salvo in the safe condition. If the bomb bay fuel tank were installed and the pilot's emergency bomb release handle pulled, the fuel tank would be released in the same manner as the bombs.

The pilot's emergency release handle is linked to the emergency release unit with a one-sixteenth (1/16) inch diameter flexible cable (6B). This cable is routed up the right-hand forward side of station seventy (70) in the bombardier's compartment and is guarded by a three-eighth (3/8) inch diameter tube. When the pilot salvos the racks the bombardier's handles do not move. After the emergency release unit has been tripped the unit has to be recocked and the following procedure should be used:

1. The arm and safe handle must be brought back to the arm position then moved forward to the safe position.

2. The door and release handle must be moved forward to the salvo position then back to the doors closed position.



BOMB DOOR VALVE & BOMB RACK ACTUATING MECHANISM SHOWN IN BOMB DOOR'S OPEN RACK LOCK POSITION

FIG. 9

The bomb doors are now closed and the emergency release unit is re-cocked.

RIGGING CONTROLS AND ADJUSTMENTS

The bomb controls, (A) and (B), in the bombardier's section, Fig. 7, should be adjusted as a unit, and disconnected beyond the emergency release unit. The arm and safe controls should be connected and operated from arm and safe positions. There should be no bind or deflection in the torque tube assembly (3) or in the emergency release assembly (6). The release rod (22) should not be connected through the emergency release unit. The release handle (A) should be moved through the arc, stopping at doors closed and salvo positions. No bind or deflection should be encountered upon inspection at all positions of the control handle. If bind or deflection results, adjustment can be made by removing the rod end bearing at the point of difficulty and shortening or lengthening the control rod, as the case may require. At this state, it would be well to trip the emergency release unit, and re-set by the use of the control handles.

The next unit to adjust is the cam, Fig. 9. The operating cam should be rotated, and the point determined where the bomb racks are locked and the bomb doors closed. The cam should be rotated slightly back and forth to determine this position exactly; the forward roller in the cam slot should be at the point where it just starts coming out of the dwell. Now set the release handle to the Doors Open Racks Locked position and connect all rods from the release handle to the cam. Next connect all control rods to their bellcranks up to the bomb door safety lock.

The inboard bellcrank (23) of the Bomb Door Safety Lock, Fig. 7, should now be adjusted. With the bombardier's release handle (A) still in Doors Closed Racks Locked position, and the retrieving pin (24) removed from the bomb door, adjust the bellcrank (25) so that the pin can enter both holes in the lock bracket, with about one-sixteenth (1/16) inch clearance.

The first consideration for adjustment of the bomb racks should be the salvo channels, Fig. 10. They are to be connected to their operating rods (35) and (36), which complete the system. You now have a complete connection from the bombardier's release handle to the Salvo channel. Operate the release handle from Doors Closed, Racks Locked position and check to see that the Salvo channel locks the cocking pawls (50) on its down stroke and salvoes on its up stroke. Due to possible variation in the fabrication of these pawls, it will be necessary to adjust to the lowest pawl in the cocked position. On each trial adjustment it will be necessary to cock the rack at all stations, for due to the above mentioned variations, the pawls may not set alike in their uncocked position. When the adjustment is complete, both bomb racks will lock alike and salvo alike.

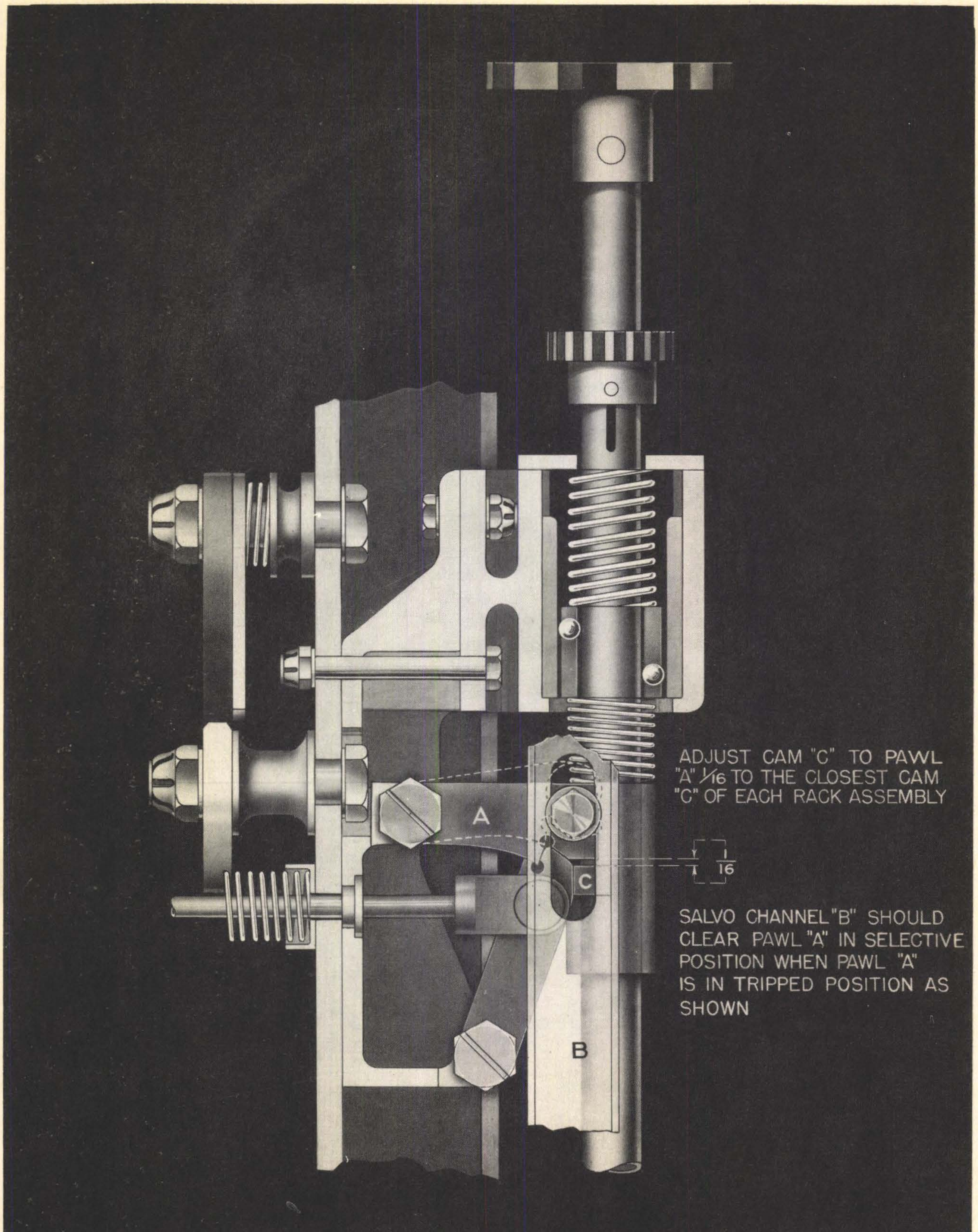

ADJUST CAM "C" TO PAWL "A" 1/16 TO THE CLOSEST CAM "C" OF EACH RACK ASSEMBLY
A
C
1/16
SALVO CHANNEL "B" SHOULD CLEAR PAWL "A" IN SELECTIVE POSITION WHEN PAWL "A" IS IN TRIPPED POSITION AS SHOWN
B

FIG. 10

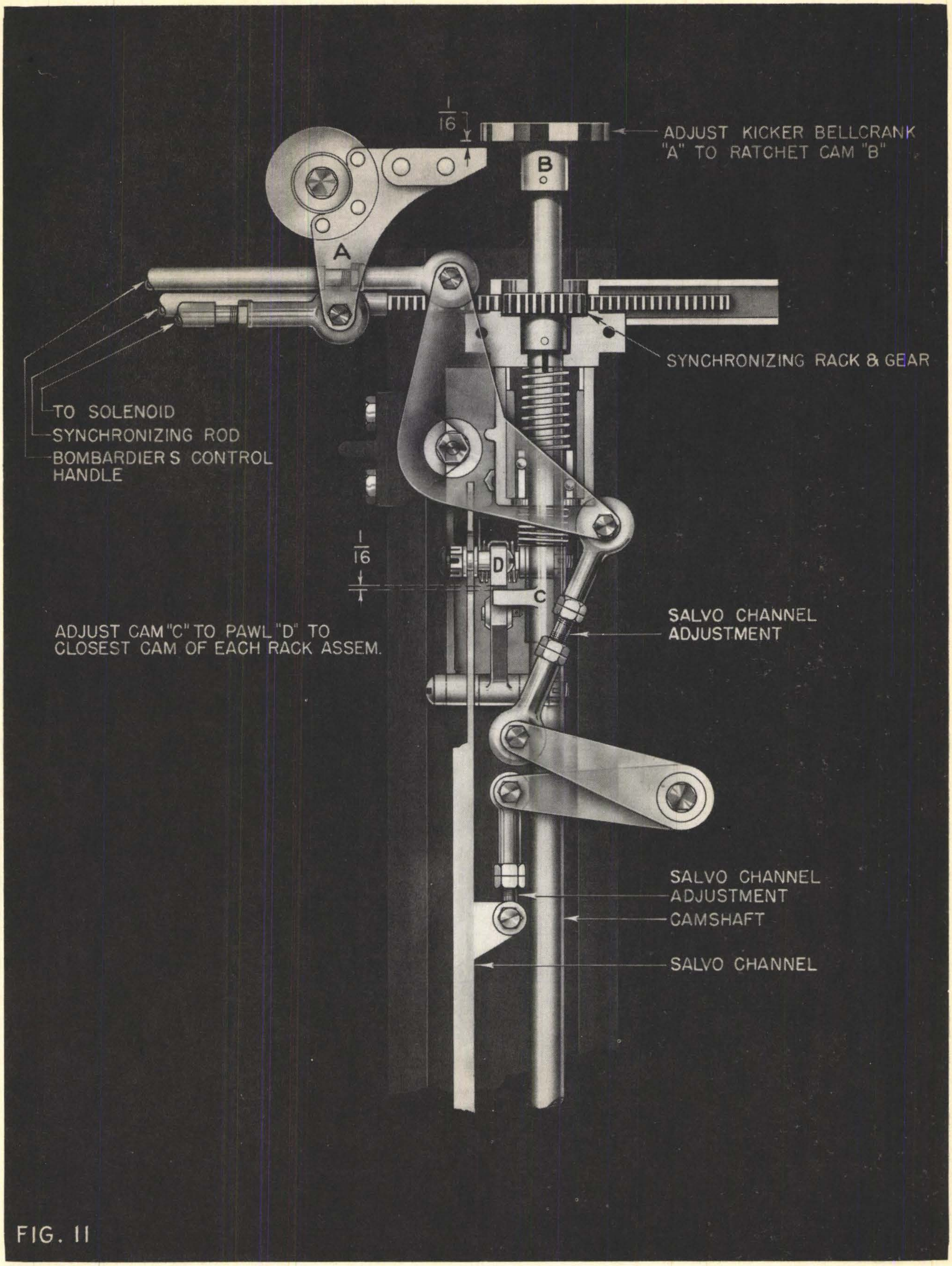

1/16
ADJUST KICKER BELLCRANK "A" TO RATCHET CAM "B"
B
A
SYNCHRONIZING RACK & GEAR
TO SOLENOID
SYNCHRONIZING ROD
BOMBARDIER'S CONTROL HANDLE
1/16
D
C
ADJUST CAM "C" TO PAWL "D" TO CLOSEST CAM OF EACH RACK ASSEM.
SALVO CHANNEL ADJUSTMENT
SALVO CHANNEL ADJUSTMENT
CAMSHAFT
SALVO CHANNEL

FIG. 11

To synchronize the bomb racks, Fig. 8, it may be necessary to adjust the synchronizing rod (54), which is provided with a right and left-hand threaded adjustment for this purpose. When the bomb racks are cocked, the solenoid (39) should raise the ratchet (45), thus firing No. 1 station on the left bomb rack first, alternating to the lower station on the right-hand rack No. 2 and continuing up the rack.

In adjusting the cam shaft, Fig. 11, the racks should be cocked, and a setting of one-sixteenth (1/16) of an inch minimum be maintained. This is accomplished by adjusting a stop, which also acts as a bottom pivot, at the bottom of the forward bomb rails.

BOMB RACKS

The bomb racks, Fig. 8, are of conventional design, of ladder construction, and are placed one on each side of the airplane. Two rails of 24ST extruded channels are separated by six (6) die cast spacers (55), upon which are mounted the brackets that hold the operating dogs (56) and (57) and indicating switch boxes (58). One set of operating dogs (57) move the arm and safe lever on the bomb shackle. The other set (56) operate the release arm of the bomb shackle.

The arm and safe operating dogs (57) are connected to the arm and safe control rod (7), and are operated by the bombardier's control handle (B).

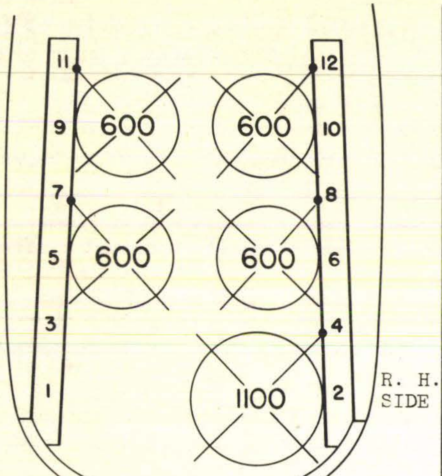
The release dogs (56) are operated by a spring-loaded clevis (59), one end of which is fastened to the dog, the other end to a release trigger.

In regular operation, when a bomb is hung on the rack, the operating dog (56) must be cocked. To accomplish this, the dog is moved forward to the cocked position, thus loading the spring (59) and moving the release trigger until it reaches the position where the cocking pawl (50) holds it in place. This procedure is followed on all bomb stations until the bomb racks are completely cocked.

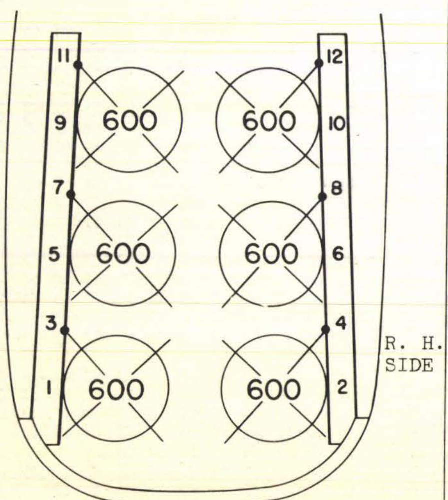
LOADING AND HOISTING BOMBS

Hoisting bombs on the B-25 airplane is a comparatively simple task. Hoist assemblies are placed on the outside of the airplane, the cables are threaded under a roller that is permanently installed, up the side of the ship, over snatch blocks and down to hook to one side of bomb sling. One hoist assembly should be used on either side of the airplane. A loading chart is shown in Fig. 12.

<u>Loading one hundred (100) pound bombs</u>: To load one hundred (100) pound bombs by hand is a much faster method than with the hoist unit, although provisions have been made for hoisting. By loading the lower station first and progressing on up the rack on both sides, hand loading would be desired.



P 4-600 AND 1-1100 LB.
APPROX WT. 3639.5 LBS.



Q 6-600 LB.
APPROX. WT. 3760.2 LBS.

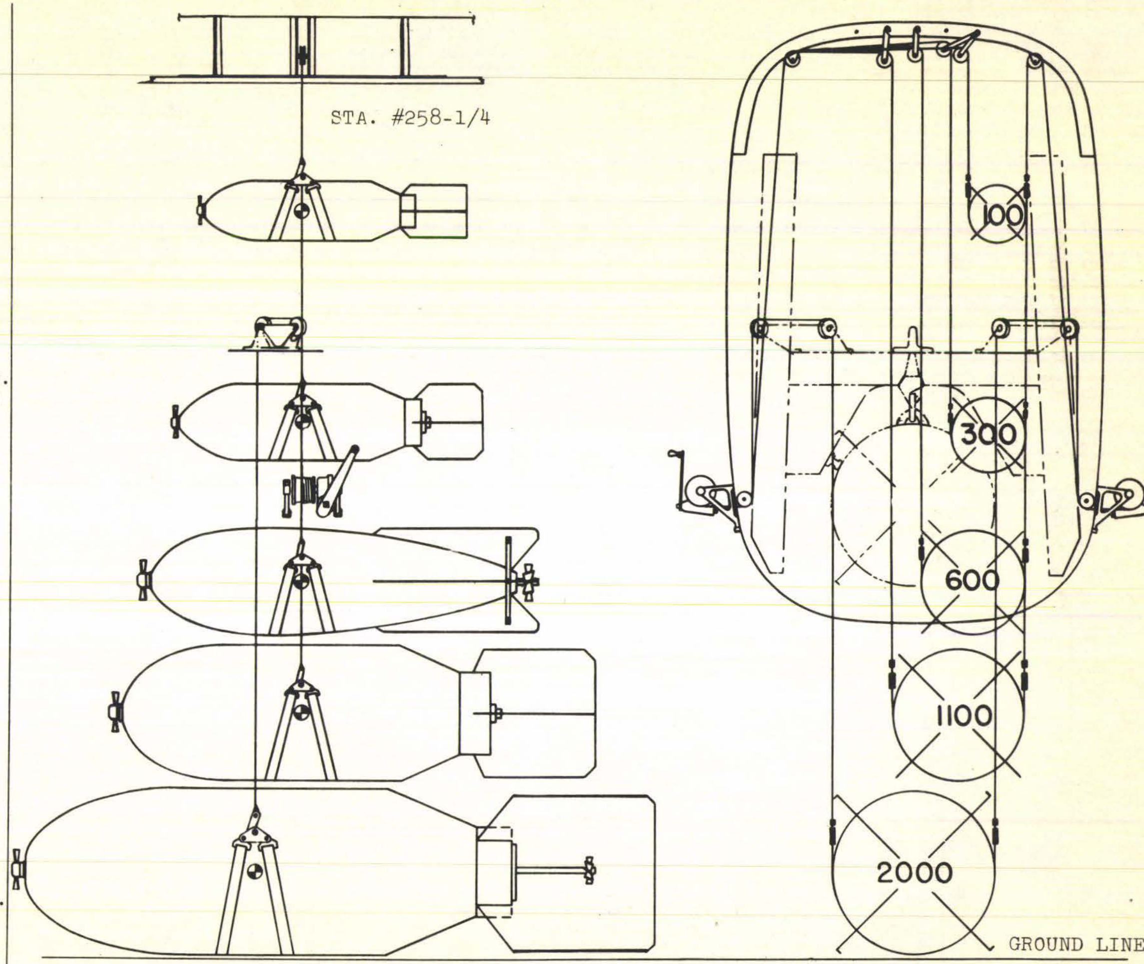


FIG. 12 OVERLOAD BOMB LOADING CHART

BOMB HOISTING CHART (B-25A AND B-25B)

To hoist three hundred (300) pound bombs: Thread cable as indicated, placing snatch block on stud for three hundred (300) pound bombs.

To hoist six hundred (600) pound bombs: Thread cable as indicated, placing snatch block on stud for six hundred (600) pound bombs.

To hoist one thousand one hundred (1100) pound bombs: Thread cable as indicated, placing snatch block on stud for one thousand one hundred (1100) pound bombs.

To hoist two thousand (2000) pound bombs on B-25 airplane: Make sure the two thousand (2000) pound bomb rack is securely fastened in place. Retract the control rods, and cock the bomb rack station which operates the control rods. Snap D-4 shackle on the hooks and see that it is properly placed. See that the shackle has the proper end forward. End marked "FRONT" should be forward. Place two (2) hoist units in proper key slots on the outside of the airplane on each side. The farthest forward and farthest aft positions are to be used. Thread cable through the door openings and under the rollers, up the side of the ship and through holes in the floor. Place snatch hooks on the studs marked for two thousand (2000) pound bombs and thread through. Hooks are then lowered and connected to ends of the bomb slings. The bomb is then hoisted in place, the mounting lugs hooked by the shackle hooks, and the shackle locked. The sway brace bolts are then brought down to the bomb and check nuts secured. The control rods can now be locked to the shackle, extended and hooked into the bomb rack operating dogs. It is best to keep tension on the hoist cables until all operations are complete.

To hoist two thousand (2000) pound bomb on the B-25A and B-25B Airplane: Make sure the two thousand (2000) pound bomb rack is securely fastened in place. Retract the two (2) control rods and cock the bomb rack station. Snap the D-4 shackle on the hooks and make certain that the correct end is forward. Place one (1) hoist unit, on either side of the ship in the key slots provided. Thread the cable through the door openings. There are two (2) hoist brackets, one on each side, on the top surface of the two thousand (2000) pound bomb rack. They slide in slides and lock in an inboard and outboard position. Slide these brackets to the outboard position and lock. Thread the hoist cable over the two (2) pulleys on the hoist brackets and lock the cable guards in place. Feed the cable down the lightening holes directly under the inboard pulleys and hook the cable to the bomb sling. As only one (1) sling is used, the bomb must be balanced so that it will hoist on a level keel. The bomb can then be hoisted in place, the mounting lugs hooked by the shackle hooks, and the shackle locked. The sway brace bolts are adjusted, and the check nuts secured. The control rods can now be locked to the shackle, extended and hooked into the bomb rack operating dogs. It is best to keep tension on the hoist cables until all operations are complete.

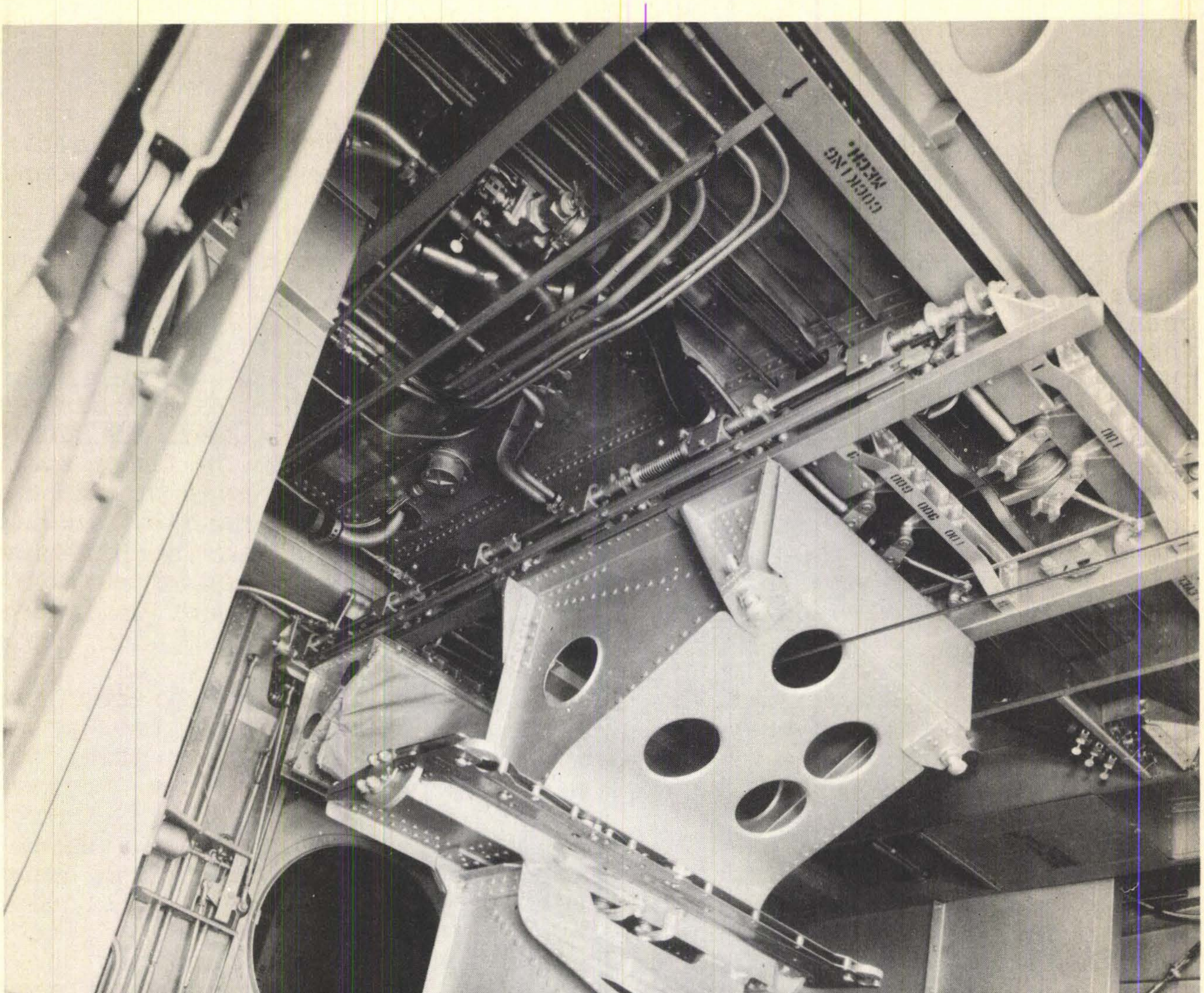


FIG. 13

CAUTIONS

When a bomb bay fuel tank is installed, extreme caution must be taken not to operate bomb control handles or the pilot's emergency release. The tank will be dropped, much the same as bombs, if the control handle is placed in salvo position, or the emergency release unit is tripped.

In the case of hydraulic failure, and it is desired to release bombs from the pilot's compartment, the bomb doors must be cranked open by the bomb door emergency operating crank. This is located in the navigator's compartment on the right-hand side of the ship at the hatchway. The crank should be mounted on the shaft and cranked fast enough to keep crank pressure on the doors as they lower. During this operation, the bombardier's control handle should be in the Doors Open position, so that any pressure in the cylinders or lines will not resist the opening of the bomb doors. The doors must be cranked open before the pilot pulls the emergency release handle. Should the pilot prematurely pull the emergency release, and the bomb racks fail to salvo, the emergency release unit must be reset (as shown previously) and released by the pilot. The bomb doors must be fully opened.

The operating cam must be properly adjusted. Improper setting will result in loss of travel in the salvo channel, sometimes preventing the salvo of the racks. It may also affect the operation of the bomb door hydraulic valve.

The bomb door safety lock pin must be properly adjusted to clear the bellcrank. It must be remembered that whenever the bomb doors are closed, the pin enters the hole in the bracket; therefore, it is necessary to have the bomb control rods hooked up when operating the bomb doors. If for any reason the controls are not complete when closing the doors, caution must be taken to see that the bellcrank is clear of the pin. A bent pin may result.

If for any reason the bomb racks may be removed from the airplane, it is not to be flown before they are reinstalled. The bomb rail assembly, complete with their spacers, are to be considered structural parts, and therefore necessary to sustain some of the forces upon the ship in flight.

The bomb racks in the B-25 airplane are simple, yet sturdy; they should require little servicing, yet give service for a long period of time with proper adjustment and just ordinary care.

GUN
INSTALLATION

NORTH AMERICAN AVIATION Inc.

Gun Install. LECTURE

B-25 SERIES AIRPLANES

PREPARED BY J. E. Schibler

NOTE

THE INFORMATION CONTAINED IN THIS LECTURE WAS CORRECT AS OF MAY 15, 1942. REFER TO HANDBOOK OF OPERATION AND SERVICE INSTRUCTIONS FOR THE LATEST INFORMATION.

N A A

INGLEWOOD, CALIFORNIA

I N D E X

ILLUSTRATIONS

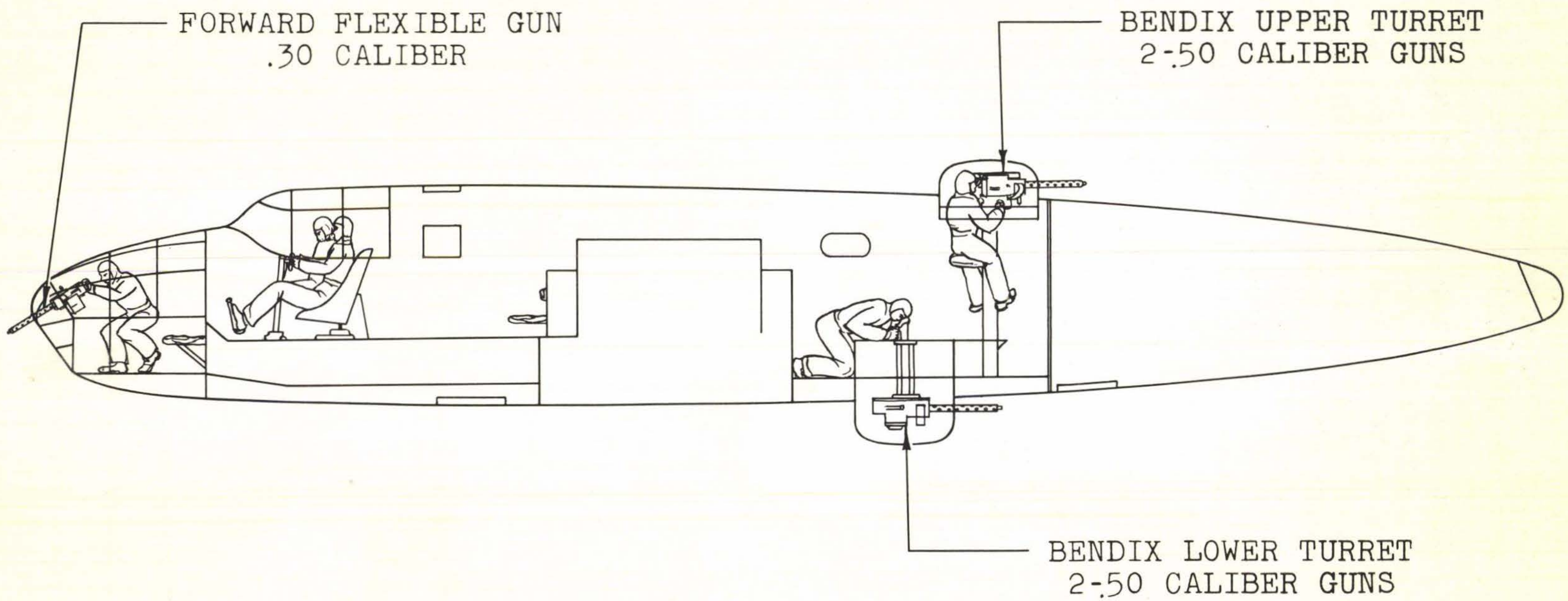


FIG. 1 SILHOUETTE SIDE VIEW OF ALL ARMAMENT (B-25C)

GENERAL

The armament on the B-25C airplane, Fig. 1, consists of one .30 caliber, Model M-2, machine gun which can be flexibly mounted in the nose, and two electrically operated gun turrets, each mounting two .50 caliber, M-2, machine guns. The turrets on the B-25C airplane are located just aft of the radio operator's compartment, one on the top and the other on the bottom of the fuselage. Each of these turrets are operated separately by a gunner; one in a sitting position in the upper turret and the other taking a restful kneeling position at the lower turret.

NOSE GUN

A .30 caliber nose gun may be used in any of three ball and socket mounts provided in the plexiglas panels of the bombardier's enclosure. This gun is equipped with a type C-17 gun mount adapter, a ball and socket mount assembly, type K-2, a type A-5 case ejection container, a type A-3 link ejection container, a type L-4 ammunition box assembly. The .30 caliber nose gun may be installed in the ball and socket mount, Fig. 2, by inserting the gun barrel through the ball and locking the gun to the ball by a spring-loaded catch on the C-17 adapter. When the gun is not in use, it may be stowed away by means of a muzzle socket and a bracket provided on the right side of the bombardier's compartment. The .30 caliber gun stows in the upper part of this bracket and is held by a lock assembly which is adjustable by turning the T-Bolt to any desired position and then tightening the lock nut. A handle at the bottom of the bracket is the means by which the bracket is held in place when used to hold a gun, or when it is not being used, it can be turned to the side out of the way. A plunger with a spring behind it keeps the pressure on the handle, and care must be taken if the bracket is ever removed not to lose the plunger.

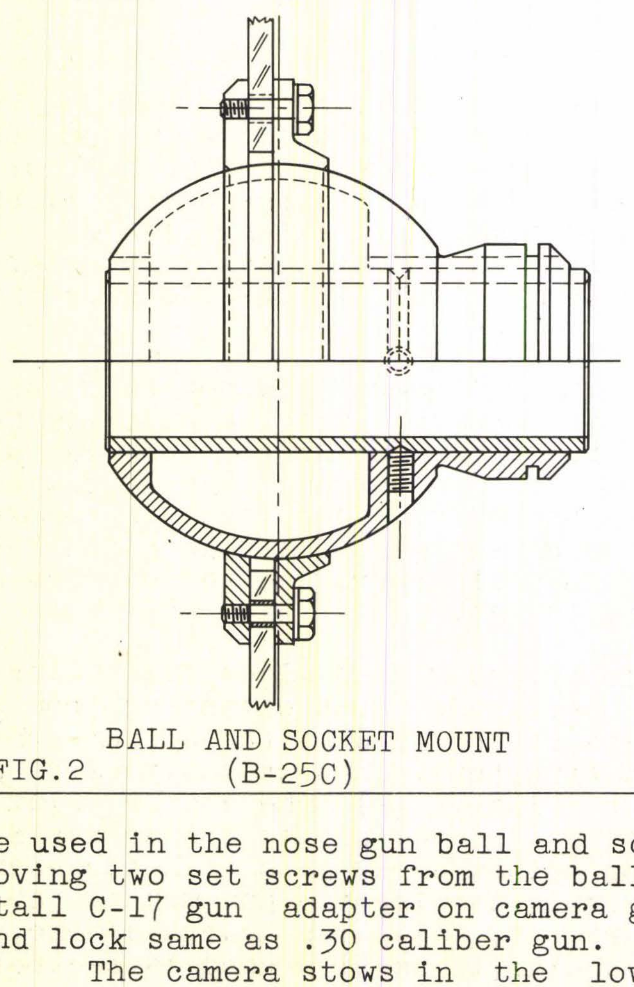


FIG. 2 BALL AND SOCKET MOUNT (B-25C)

A type G-4 camera gun may be used in the nose gun ball and socket mounts. This is done by removing two set screws from the ball and removing the bushings. Install C-17 gun adapter on camera gun and insert barrel through ball and lock same as .30 caliber gun.

The camera stows in the lower part of the same bracket in

which the .30 caliber gun stows and on an arm located on the longeron. This arm can be kept at any desired position by tightening the knurled nut. A small lock trigger at the end of the arm must be retracted into the arm when removing the gun camera.

B-25C TURRETS

Construction of the turrets are such that they may be rotated continuously in azimuth (horizontal plane). The upper turret guns may be elevated from 180° zenith (straight up) to 8° above the horizontal. The lower turret guns may be elevated from 180° nadir (straight down) to 2° above horizontal firing aft and 11° below horizontal firing forward.

Motive power for the azimuth rotation of the turrets is furnished by a 24-volt D. C. motor in each turret, developing 1 HP at 5000 RPM, and having a no load speed of approximately 6000 RPM. A similar motor is used in each turret for depressing and elevating the guns. The turret operator controls the speed and direction of rotation of both motors from a single control handle. Turret rotational speeds vary from a minimum of 1/4 degree per second to a maximum of 40 degrees per second.

LOWER TURRET

The upper and lower turrets have similar functions but due to the retractable feature of the lower turret discussion will lead to it first. The Bendix Model J lower turret is a twin .50 caliber, electrically controlled, retractable turret. It fares nearly flush with the fuselage in the retracted position and extends 12-3/4 inches downward to combat position. The lower turret assembly weighs approximately 392 pounds less guns, ammunition, firing solenoids and gun chargers.

Provisions are made for 390 rounds of ammunition per gun. Ammunition boxes are bolted to the lower canopy, which can easily be removed from the turret assembly by removing four bolts. Observation windows are provided at each side of the gun turret. The window on the right side of the fuselage just above the floor level is removable and large enough to be used as an emergency escape hatch for the turret operator. The empty cases and links are ejected overboard through a chute at the bottom of the turret.

The lower turret, Fig.3, is comprised of four major assemblies: (1) The spider assembly which has four spider arms emanating from a centrally located "nut". Four bolts at the end of the spider arms secure the assembly to the airplane structure. This assembly carries the entire load of the turret center column. (2) The center column screw assembly is secured to a nut in the center of the spider assembly. External threads on the center column screw mate with those on the nut. (3) The lower housing assembly carries the gun mounts, ammunition containers, elevating gears, etc. (4) The fourth assembly is the periscopic sight which is tubular in section and is secured

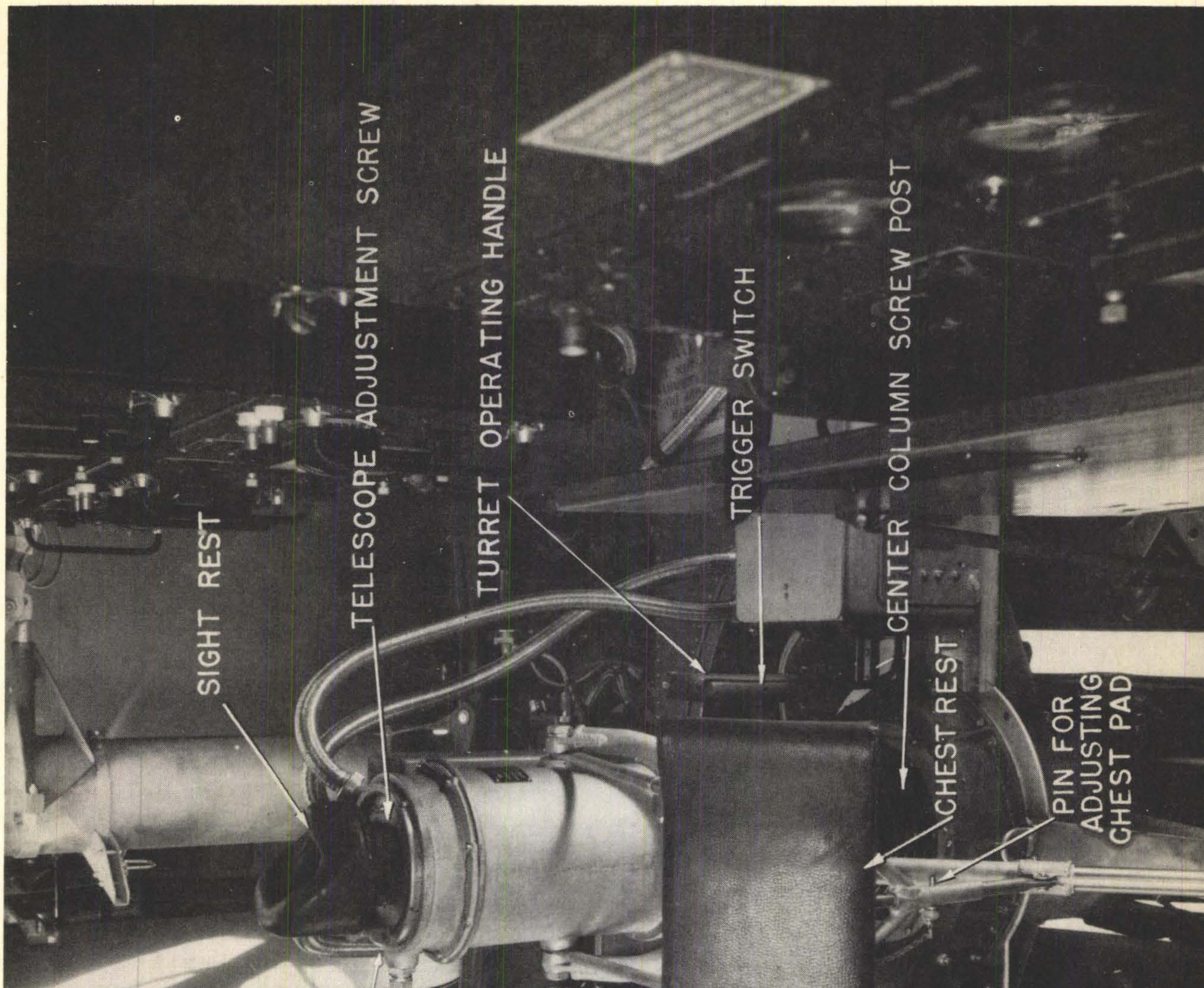

SIGHT REST
TELESCOPE ADJUSTMENT SCREW
TURRET OPERATING HANDLE
TRIGGER SWITCH
CENTER COLUMN SCREW POST
CHEST REST
PIN FOR ADJUSTING CHEST PAD
RETRACTING LEVER
AZIMUTH RETRACTING MOTOR
MICROPHONE SWITCH BUTTON
EMERGENCY HATCH
STEADY HAND REST
HYDRAULIC GUN CHARGING HANDLE
SPIDER ARMS

FIG. 3

within the center column in the exact center of the turret. The eye piece is at the top of the center column and the object prism, which moves in elevation with the guns, is located at the bottom of the lower housing. The entire sight rotates in azimuth with the turret.

The azimuth motor, which rotates the turret in azimuth, (about its vertical axis) is also used to extend and retract the turret. This is accomplished by the azimuth motor turning the nut which mates to the center column. When azimuth rotation is required, a dog locks the nut to the screw and the assembly turns as a whole. In extension or retraction, the dog is disengaged and the nut rotates about the screw, raising or lowering the turret as desired. The operator desiring to retract an extended turret, releases the locking dog by actuating the retract lever at the top of the turret. There is an electrical interlock system between the retract lever and the guns so that the turret cannot be retracted unless the guns are at the proper index position in elevation. Extending, operating, and retracting the turret is both rapid and simple if the following procedure is used.

LOWER TURRET NORMAL OPERATION

When ready to operate turret, throw toggle switch on side of control box to "ON" position. The switch should be turned to the "OFF" position after the turret is retracted to stowed position.

A. Extension to combat position:

1. Firmly grasp control handle with right hand to depress master switch, but do not depress trigger switch.
2. Turn control handle counter-clockwise about vertical axis a few degrees for slow speed and maximum rotation for full speed.
3. Caution: As turret approaches extended position, use slow speed until indexing key automatically engages and turret starts to rotate counter-clockwise. Guns can be fired as soon as extended position is reached.

B. Charging the Guns:

1. To charge guns ready for combat or to remove faulty cartridge; depress control valve with knob rotated clockwise against stop (after depression knob is automatically released at end of charging stroke, thereby positioning valve for next charging stroke).
2. To charge guns and hold the bolt back in safety position depress control valve with knob rotated counter-clockwise against stop. When ready to release for combat, rotate knob clockwise against the stop.

C. Combat Operation:

1. Lower the padded knee support in well forward of turret.

2. Adjust chest support as required by means of spring-loaded pin in chest support rod.

3. Take kneeling position with right hand on control handle, left hand on steady grip and eye on sight eye cushion.

4. Neutral position of control handle is half-way between vertical and horizontal rotation stops.

5. To rotate turret in azimuth, rotate control handle horizontally about its vertical axis. Turret will move in same relative direction as handle, at a speed proportional to the degree of control handle rotation.

6. To elevate the guns, rotate control handle vertically about its horizontal axis. The guns will move in same relative direction as handle, at a speed proportional to the degree of control handle rotation.

7. Turn on windage compensator switch and rotate rheostat control to indicated air speed of aircraft determined from pilot. Microphone switch button is located in end of steady grip. Windage compensator on lower turret is connected to both upper and lower turret sight.

8. To fire guns, depress trigger firing switch in control handle.

9. Power is cut off by releasing grip on control handle.

D. Retraction to Stowed Position:

1. Rotate turret slowly in clockwise direction with guns positioned approximately 12° below horizontal. As guns approach aft position, firmly depress retraction lever, which will cause turret to stop.

2. Slowly raise guns in elevation, keeping control handle set for slow azimuth speed in clockwise direction, and retraction lever depressed. When guns enter index zone (2 to 6 degrees below horizontal) turret will again turn clockwise, index and start retracting.

3. Caution: Control handle must be kept at slow speed until turret begins to retract.

4. After turret has retracted approximately one inch, release retraction lever, and continue retraction at any desired speed to stowed position.

LOWER TURRET GUN CONTROL

Provisions are made for bore sighting the guns and adjusting the sight so that the gun fire and the sight recticle may harmonize. Inspection windows are provided at the rear of each gun through which the bolt and gun barrel may be removed for servicing. The turret is equipped with Bendix hydraulic gun chargers which charges both guns when the operator depresses the charger valve plunger with the handle rotated clockwise against the stop. The hydraulic oil lines from the ship's accumulator and reservoir attach to the charging valve with standard fittings. After passing through the valve, the oil is fed through a hydraulic gland to an oil line running through the turret center column and through flexible hose branches from the line to each gun charger.

LOWER TURRET ELECTRICAL CONTROL

Electrical limits and dynamic brakes are provided to prevent mechanical damage and also to control the zone of gunfire. Cam and wafer switches, actuated by azimuth rotation of the turret and elevation of the guns, are used to control the automatic electrical circuits. The field of fire is controlled by switches which open the circuit to the firing relay in order to miss such objects as wing tips, tail surfaces, etc. A blue warning light is provided on the pilot's main switch panel to warn the pilot when the landing gear and turrets are extended at the same time. No provisions have been made to blank off the turret gunfire on the landing gear or bomb bay doors. A down limit elevation cam switch stops the guns when they approach the 180° nadir point (straight down). In order to converge fire between the upper and lower turrets, the guns are allowed to elevate beyond the horizontal. This, however, is only possible on the sides and aft regions of the plane due to the fact that at this elevation the guns would strike the fuselage in the forward position. Series circuits between the azimuth cam switches and elevation cam switches are provided to stop the turrets in azimuth or the guns in elevation when they approach the fuselage. A similar series of circuits is used to provide two upper limits - one forward and one for the sides and aft position of the plane.

The motors used to drive the turret in azimuth and the guns in elevation are 24-volt shunt motors. Motor speed is controlled by varying the voltage to the armature. This is accomplished by breaking up the armature supply voltage and feeding it to the armature in a series of controlled pulsations of varying wave form. The turret operator varies this wave form by movement of the control handle. When the wave has a very narrow crest, the motors rotate at very low speed and increase their speed as the crest of the wave is widened. Reversal of the motor is obtained by reversing the motor field. This is done automatically each time the control handle passes the centered (neutral) position.

UPPER TURRET

The Bendix Model L upper turret, Fig. 4, 5, is a twin .50 caliber, electrically controlled turret. Provisions are made for 440 rounds of ammunition per gun. The gunner assumes a sitting position while operating the turret; the turret has a one piece Plexiglas bowl top with slots provided for the operation of the guns and a cut-out for the gun sight. The gunner's head and top of shoulders are above the fuselage and are covered by the turret top, which gives the operator an unobstructed field of vision. A flexible chute under each gun retards speed of ejected cases and links before they are dropped to the floor. Electrical provisions are made to prevent firing on the airplane except radio antenna and mast. The complete turret assembly and operator revolve in azimuth around the vertical axis.

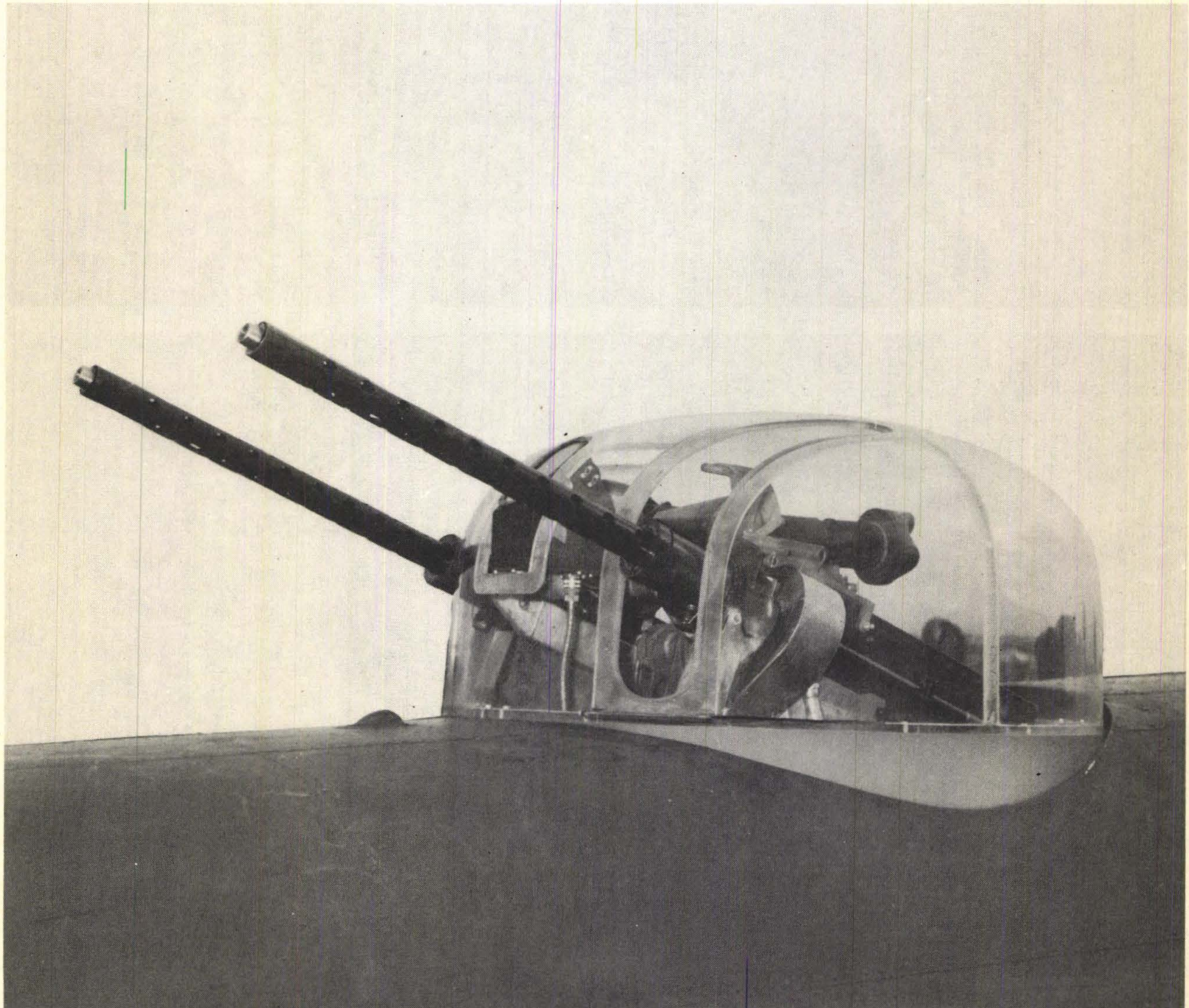


FIG. 4

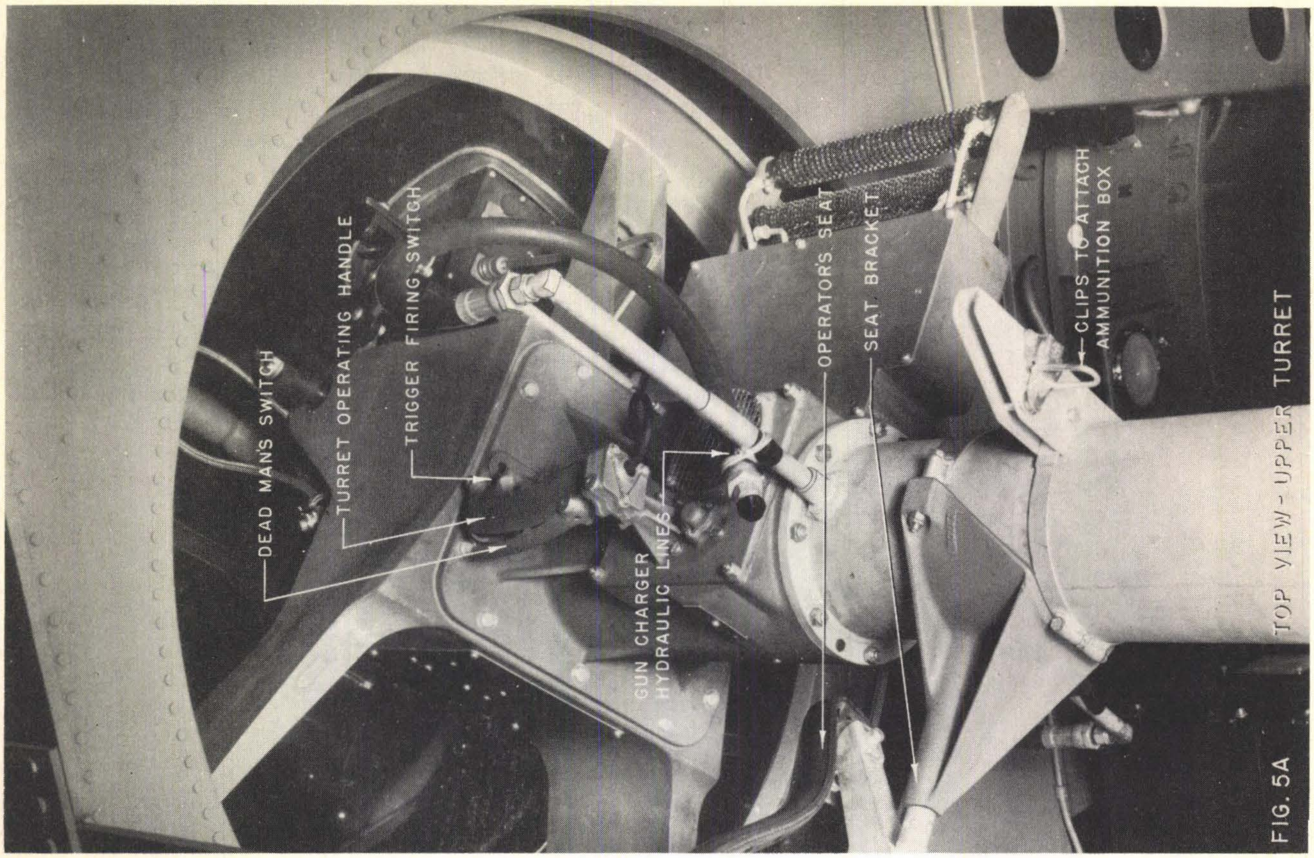


FIG. 5A TOP VIEW - UPPER TURRET

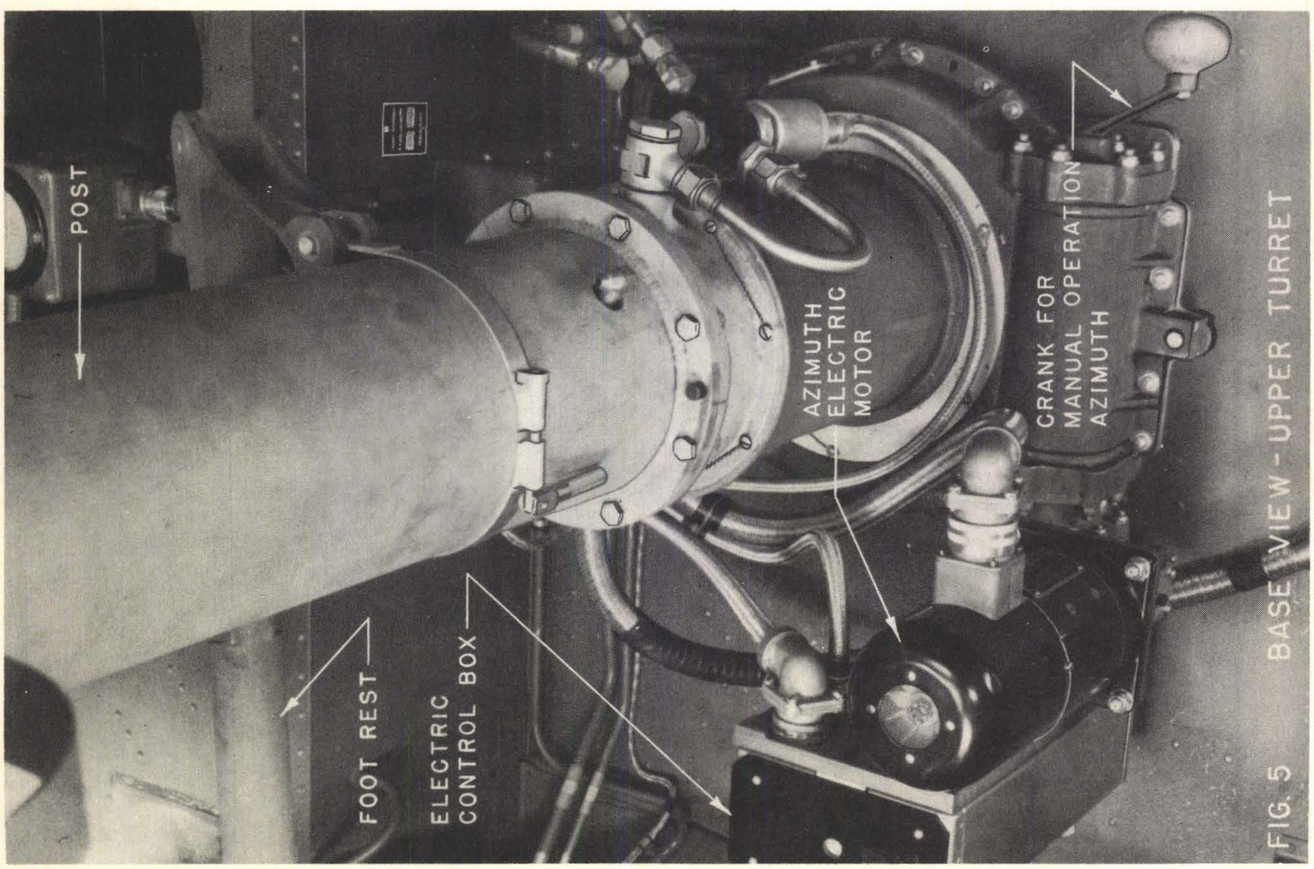


FIG. 5 BASE VIEW - UPPER TURRET

UPPER TURRET NORMAL OPERATION

When ready to operate turret throw toggle switch on brush box at base of turret to "ON" position.

The gunner may enter the upper turret, Fig. 4, by pushing riding seat to either side and extending foot rests.

Caution: Do not touch master control handle. Enter turret placing leg over seat and rotate seat into place. Adjust foot rest as required, by loosening hand screw at the aft side of the support attaching bracket. When through operating turret throw toggle switch to "OFF" position.

CHARGING GUNS

To charge the guns or remove faulty cartridge, depress gun charger button. Note: Do not hold charger button depressed over 30 seconds (gun charger button is located on left-hand side of post and is the lowest of the two).

COMBAT OPERATION

1. Neutral position of control handle is half-way between vertical and horizontal rotation stops.

2. To rotate turret in azimuth, firmly grasp control handle with right hand to depress master switch. Rotate control handle horizontally about vertical axis. Turret will move in same relative direction as handle at a speed proportional to degree of control handle rotation. Note: Do not depress trigger firing switch, as guns are operative as soon as master switch is depressed.

3. To elevate the guns, rotate control handle vertically about its horizontal axis. The guns will move in same relative direction as handle and at a speed proportional to the degree of control handle rotation.

4. Rotate the sight eye cushion as required to focus sight for individual requirements.

5. Turn on windage indicator switch located on lower turret and rotate rheostat control to indicated airspeed of aircraft determined from pilot. Microphone switch button is above gun charger button located on left-hand side of post.

6. To fire guns, depress trigger firing switch in control handle.

UPPER AND LOWER TURRET EMERGENCY OPERATION

Warning: Firing restrictor cams and turret control cams, which are used, electrically stop the gunfire and turret rotation at predetermined positions and are disengaged when operating turret mechanically. Therefore, when rotating turret or moving guns in elevation, make sure guns are not moved beyond the normal limits. Also when retracting lower turret manually, stop retraction when pad on housing arm touches retract limit switch.

LOWER TURRET EMERGENCY OPERATION

1. Remove required transparent sections on turret deck.

2. Engage hand crank in manual gun elevation shaft and rotate crank as required to position the guns approximately two to six degrees below horizontal.

3. Engage hand crank in manual turret control shaft and pull shaft forward to disengage clutch from reduction gear mechanism.

4. Rotate turret until guns are slightly to left of aft position. Firmly depress retraction lever and rotate turret clockwise holding retract lever depressed.

5. When aft position has been reached, turret will begin to retract. Hold retraction lever depressed until turret has retracted approximately one inch, then release lever and retract turret to stowed position.

6. Caution: Do not raise turret beyond the point where the aft turret support brace contacts the limit switch, located below aft leg of the spider, as damage to the turret will result.

7. Replace section of transparent fairing on turret deck.

8. To re-engage turret for electrical operation, refer to Handbook of Instructions for Bendix Turrets.

UPPER TURRET MANUAL OPERATION

Note: Crank stowed on lower turret shall be used for manual azimuth rotation of upper turret. A crank extension is provided for the above crank to manually elevate or depress the upper turret guns. Crank stowed on lower turret shall be used for manual azimuth. The steps for manual control of the upper turret are as follows:

1. Engage crank with extension attached in upper end of gun elevation motor shaft and rotate crank as required to position guns so that they will clear fuselage when turret is rotated to aft position.

2. Engage hand crank, Fig. 5, in forward end of manual turret control shaft. Pull shaft forward by means of crank to disengage shaft

from reduction gear mechanism. Then rotate turret as required to position guns in aft position.

3. To engage turret for electrical operation, refer to Handbook of Instructions for Bendix Turrets.

ARMOR PLATE

Armor plate is provided on the seat and back of bombardier's riding seat. Armor plate is attached to the rear of the pilot's and co-pilot's seat and moves with the seat in fore and aft adjustment. An armor plate bulkhead is provided just aft of the upper and lower turrets. An armor plate door is provided in this bulkhead to provide accessibility to all sections of the airplane.

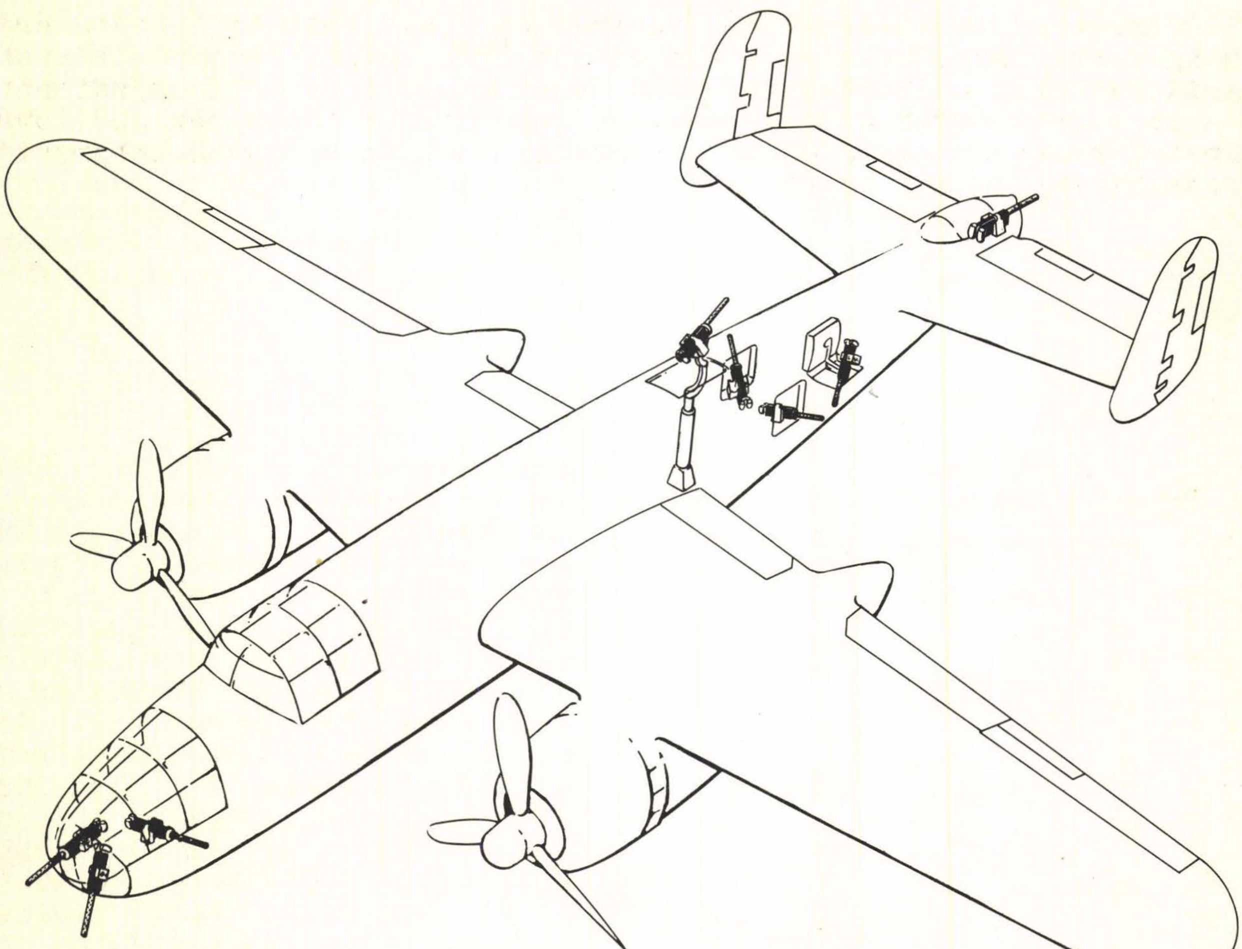


FIG. 6 SILHOUETTE SIDE VIEW OF ALL ARMAMENT
(B-25 AND B-25A)

ADDENDUM I

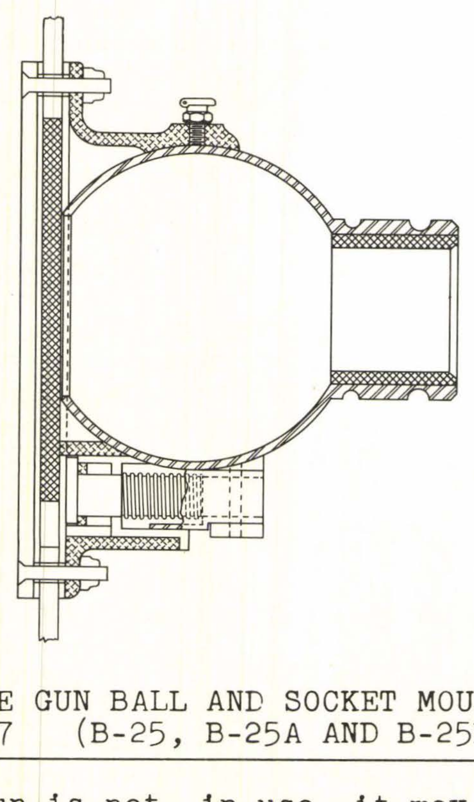
Items peculiar to B-25 and B-25A Airplanes only.

1. GENERAL

The armament on the B-25 and B-25A airplanes only, Fig. 6, embrace three .30 caliber, Model M-2, machine guns and one .50 caliber, Model M-2, machine gun. The three .30 caliber, Model M-2, machine guns may be flexibly mounted; one as a nose gun, one as a top waist gun, and one as either a side or a floor waist gun. Near each of these guns are boxes for 600 rounds of ammunition. One .50 caliber, Model M-2, machine gun may be flexibly mounted in the tail gun position. Boxes for 200 rounds of .50 caliber ammunition are provided at the tail gun position. Case and link ejection containers are provided for the .30 caliber guns only. An additional .30 caliber gun may be stowed on one of the side waist gun mounts.

2. NOSE GUN

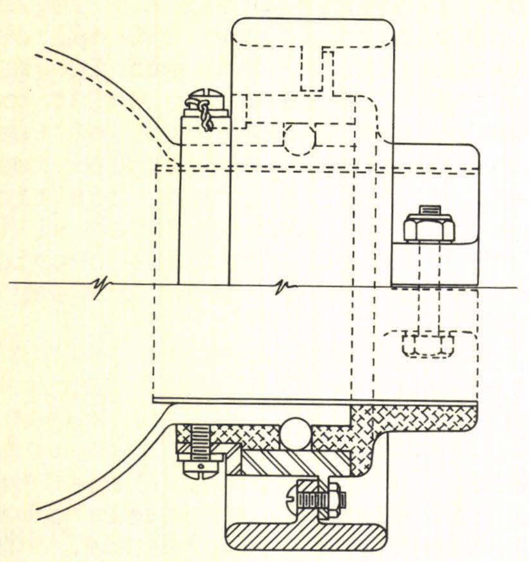
A .30 caliber nose gun may be used in any one of three ball and socket mounts, Fig. 7, provided in the plexiglas panels of the bombardier's enclosure. The gun may be installed in the ball and socket mount, Fig.7, by first opening the gun mount door handle (B) and turning the handle counter-clockwise away from the mouth of the mount. Insert the gun barrel through the ball (C) and lock the gun to the ball by turning the knurled ring on the mount adapter so that the word "LOCK" is at the top. When closing the gun mount door, center the ball (C) in the mount socket (D) so as to provide clearance at E-F and the door (A) when it is swung in the closed position. This gun is equipped with a type C-12 gun mount adapter, less yoke and R. H. side plate; a ball and socket mount adapter; a type A-4 case ejection container; a type A-4 link ejection container; and an L-4 ammunition box assembly. When the gun is not in use, it may be stowed away by means of a muzzle socket and a bracket provided on the right side of the compartment.



NOSE GUN BALL AND SOCKET MOUNT
FIG.7 (B-25, B-25A AND B-25B)

3. CAMERA GUN

A type G-4 camera gun may be used in the nose gun ball and socket mounts (Fig. 7). To do this, the .30 caliber ball and socket mount adapter must be replaced with a camera gun adapter (Fig. 8). This is done by removing the two fillister head screws securing the retainer ring to the gun mount adapter.



FLEXIBLE CAMERA GUN BALL
FIG.8 MOUNT ADAPTER

Warning:- First Remove the two fillister head screws, securing the retainer ring to mount adapter. Note: Exercise care when removing this retainer to prevent the loss of the .125 diameter steel ball, and .125 diameter 5/16 inch steel pin and the two springs, held in place by the retainer ring. Second - Pull machine gun ball mount adapterfrom adapter assembly and install in its place the gun camera ball mount adapter. Reassemble parts removed and safety retainer screws with wire. Third - Install camera adapter assembly over end of type G-4 camera gun barrel, using fiber bushing between adapter assembly and camera gunbarrel. Secure adapter to camera gun barrel with two bolts and nuts provided with adapter. Fourth - In order to install the type G-4 gun camera assembly in any of the three ball and socket mounts in the bombardier's compartment enclosure or in the lower waist gun mount, it is necessary to remove bushing, secured in barrel of mount with a screw.

The gun camera stows in the lower part of the same bracket in which the .30 caliber gun stows, and on an arm located on the longeron. This arm can be kept at any desired position by tightening the knurled nut. A small lock trigger at the end of the arm must be retracted into the arm when removing the gun camera.

4. TOP WAIST GUN

A fixed anti-aircraft type gun post centrally mounted in floor of fuselage is provided for flexibly mounting a .30 caliber gun at the upper waist gun opening. The post is equipped with a rotating off-set arm gun mount which locks in eight positions. This gun is equipped with a type C-12 gun mount adapter;a type A-4 case ejection container; a type A-4 link ejection container and an L-4 ammunition box assembly. The gun may be stowed on the mount by securing end of barrel in holder located at the forward end of the gun opening. The wind deflector stows forward of the gun opening and is released by

pulling the trigger on the centerline of the airplane.

The gunner operates the gun from a standing position through an oblong opening provided with sliding transparent doors. At the top of the post is a handle which operates a clamp on an inner extension tube. By releasing the clamping action, the gun may be raised and then locked in position to get a better firing angle. The doors are in two sections and open downward. An operating handle is provided for each section, and locks for both positions are incorporated in the door tracks. A gunner's safety belt is provided. Five of the six ammunition boxes are located opposite the gun mounting post at the right side of the fuselage. The remaining box is located immediately forward of the radio operator's seat. An air deflector provided for the opening, operates on hinges and may be readily moved into place after doors are opened.

5. SIDE WAIST GUN

A .30 caliber gun may be mounted on a fixed post at both side waist gun openings. This gun is equipped with a type C-12 gun mount adapter; a type A-4 case ejection container; a type A-4 link ejection container and an L-4 ammunition box assembly. A ball and socket mount adapter and a yoke holder assembly are provided for the installation on one of the side waist guns so that it may also be used in the floor waist gun mount. The yoke holder must be maintained in the disengaged position when gun is installed at a side waist gun position. The side waist gun may be stowed at the right side with muzzle pointing forward, or at the left side with the muzzle pointing aft, by means of the gun mounts and muzzle stowage clips provided. To place the side waist gun from a stowed position to the firing position or vice-versa, it is necessary to remove gun from mount and reinstall gun on mount with muzzle pointing in the desired direction.

The side windows are provided with operating handle at the top with locks for the open and closed positions incorporated in the tracks. On the sill below each window are two holes with dzus fastener springs mounted on the lower side. These springs are used as fasteners for the camera rest, which is a channel section with a rubber insert to be used to rest a camera on while doing oblique photography through the window opening. The bracket is provided with winged type dzus studs at both ends as a means of fastening the bracket to the sill. The camera rest bracket is stowed in a vertical position on two clips provided with dzus springs, which are located on the left side of the ship, close to the first frame forward of the window.

6. LOWER WAIST GUN

The .30 caliber, lower waist gun mount is located in the rear entrance hatch (Fig. 9). A handle (A) on the inside of the airplane located in the forward, left-hand corner of the hatch, is the means by which the door is operated from the inside and also the means by

which the gun mount is operated.

The door (B) may be operated as a hatch without releasing the gun mount (H) by pulling straight up on the handle and pulling hatch open. Do not turn the handle, for if this is done the gun mount and its door will be released and thus prevent exit through the hatch opening. When the door has been raised free of the opening, the handle can be released and the door given a push against the right side of the ship where there is a clip (C) which will engage two dzus fastener springs (D) located in the top of the door, and hold the door in the open position. To operate from the outside, push in on the end (E) of the handle nearest the Corbin lock (F), and then pull down on the long end (G) until the pins are retracted and the door pushed to the inside. Care must be taken to remove the key from the Corbin lock in the open position before operating the handle. Difficulty has been experienced in service because the handle has been operated, and while the short end of the handle has been inside the door, the Corbin lock has been locked before removing the key. The lock keeps the handle from returning to its normal position and in the effort to close the handle, a strain is placed on the lock which it is unable to stand and damage has resulted.

To release the gun mount (H) to its useful position, pull up and turn handle clockwise, and pull hatch open. The mount consists of a yoke (J) and socket (I) supported by an arm (K). A ball and socket adapter, same as used on nose gun, and yoke holder are provided on one of the side waist guns so that it may be used in this lower waist gun mount. To install the gun, push forward on the gun yoke and then turn the yoke holder handle down so that the pins on the holder straddle the yoke. This keeps the yoke in one position while the gun is placed at any firing angle. Insert the gun barrel through the ball of the mount socket and lock the gun to the ball by turning the knurled ring (L) on the mount adapter.

To place the gun mount (H) back into its stowed position in the hatch recess (M) completely close hatch with the handle turned clockwise. While the door is closed, turn the handle to its normal position, and open the hatch until the trap door on the outside is accessible. Close the trap door as far as possible, and then by giving the main handle a twist clockwise the latch will be retracted and the trap door can be completely closed.

7. TAIL GUN

On B-25 and B-25A only, provisions are made for the installation of a .50 caliber machine gun, equipped with a Bellshock mount in the tail gun position. Link and case ejection containers are not provided. A type Q-3 fixed telescope gun sight, in which the reticle is operated by the movement of the gun, may also be installed. The tail gunner fires gun from a sitting position through mechanically operated clam shell doors. To operate doors, set operating ratchet pawl in the desired position and operate handle. The operating handle must be stowed at the left side of the compartment when not

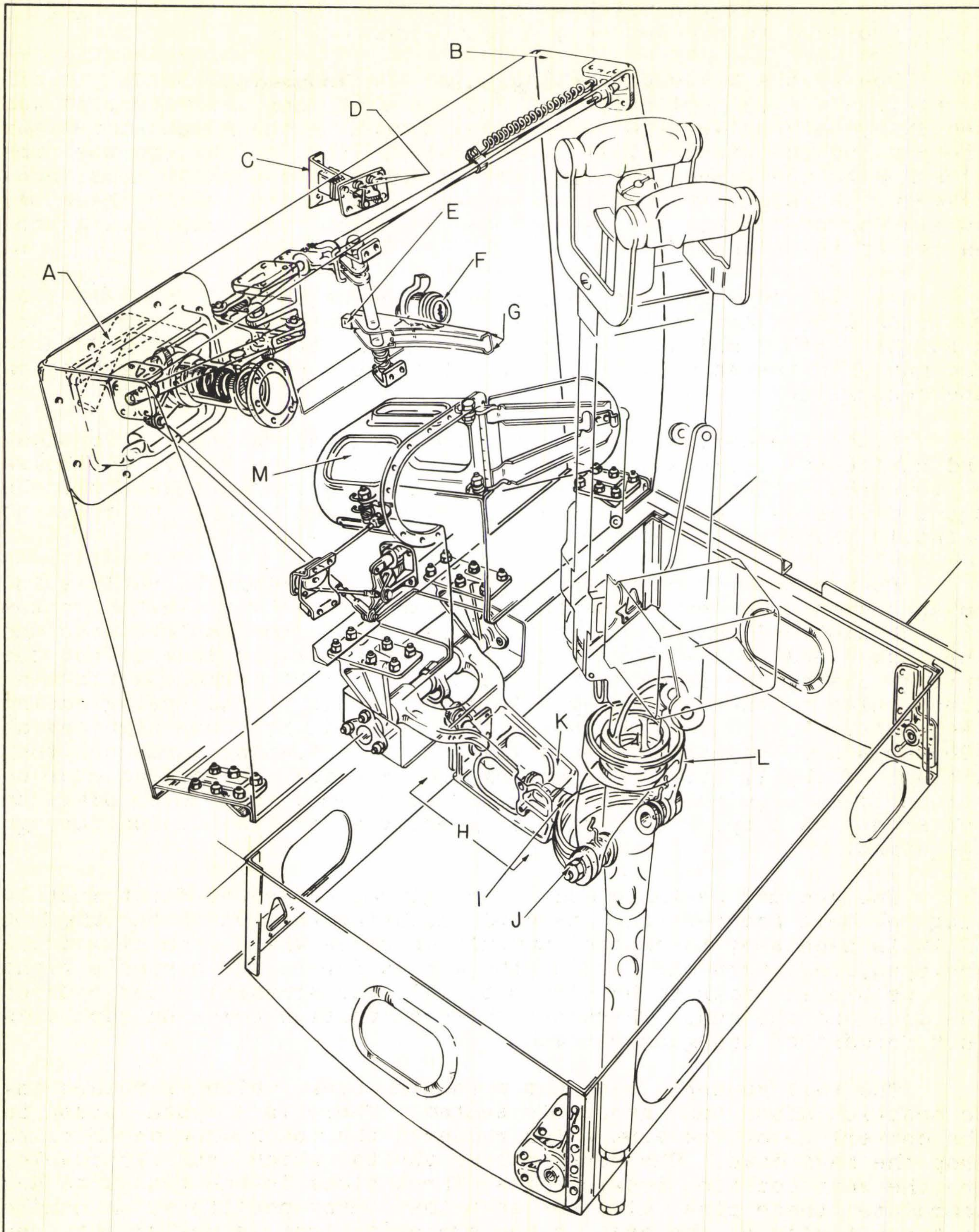


FIG. 9 REAR ENTRANCE HATCH AND GUN MOUNT MECHANISM

in use. Stow tail gun prior to closing clam shell doors by engaging clamp provided to bracket on gun mount adapter.

Due to the Q-3 sight having a 40° cone of sight (or 20° in all directions off centerline), and the gun a 60° cone of fire, it was necessary to provide a 10° overtravel system in the movement between the gun and the sight. This overtravel is incorporated in the arms attached to the gimbal. To install the sight, the sheet metal hood covering the sight opening must be removed.A casting under the hood, consisting of a base and a cap are provided for supporting the barrel of the sight.

To rig the sight cables, time the gears so that the 3/16 diameter ball hole and slot on the vertical drum on the gimbal are straight up ±5°, and on the horizontal drum straight aft ±5°.Latch the gun with the stowing bracket so that the gun is approximately on the centerline.

Place the cables in the bottom of the slots in the vertical and horizontal drums and insert the 3/16 diameter balls in the holes to lock the cables. When this is done the spring casings should be equal distances between pulley and sight drums. Tape the drums to maintain these cable locations.

Rotate both drums on the sight so as to bring the reticle into approximate center of the field. Place the cables in the bottom of each slot and insert pin in the hole to lock the cable. Wrap the turnbuckle end of the cable 2-1/2 turns on the sight drums. Wrap the spring casing end of cable 2 turns on the sight drums and tighten turnbuckles so that the plunger is just visible in the spring casing peep-hole. Fine adjustments may then be made by bore sighting at 100 yards and adjusting the bolts on the actuating arms of the gimbal. If the limits for adjusting are exceeded, the cables must be relocated as required on the drums. Never remove any cover plate on the sight, as a speck of dust will greatly affect the vision through the sight.

The gun may be installed in the gimbal easier by first installing the Bell Adapter and afterwards mounting the gun in the adapter. If it is necessary to change ammunition boxes while the clam doors are open,first turn the back of the gun as far to the gunner's right as possible in order to have room to pull the ammunition box between the door and the gun. There are three ammunition boxes on each side just forward of the gunner's seat.

The tail gunner's seat has a folding back, which is raised into position after the gunner is seated. There is a push-button on the centerline of the seat which releases the back when desiring to drop the back down. The rear roller shafts, which are retractable, are the seat position locking pins. Three slots in the tracks to accommodate these pins, give the seat that many positions. A handle on the aft side of the seat to the gunner's right is pulled up to retract the pins. To remove the seat, first take out the stops at the forward end of the tracks, then by pushing the seat as far forward

as possible, the forward rollers can be raised out of the tracks. By then rolling the seat aft, the aft rollers can be raised from the tracks.

The escape hatch is removable from either the inside or the outside. To release from the inside, the small handle on the gunner's right side is pulled toward him, which frees that side of the hatch. It is then turned about its hinge points on the other side until the hinges become free and the hatch can be discarded. On the outside of the fuselage is a ring attached to a sheet metal strip. A screw head fastens down on the metal strip, and care must be taken not to fasten the screw too tight. By pulling the metal from under the screw head, the screw is allowed to drop into the fuselage, thereby releasing the escape hatch lock.

The clam shell door operation occurs through a pumping action of the handle provided, which slips on the ratchet casting. The pawl must be shifted to one side or the other, depending on which side the motion is desired. The ratchets transmit the motion through a locking mechanism to a gear. The locking mechanism keeps any air loads on the doors from moving them, and all motion must come from the ratchet end. The gear operates a rack to which are fastened two tubes running aft to a casting. Attached to this casting are two arms which also attach to crescent shaped castings, which are the door hinge arms. A fore and aft movement of the casting at the end of the tubes, causes the arms attached to it to force open, or pull closed the door hinge arms. All bearings in this system are oilite which will require no oiling or greasing. If at any time it becomes necessary to change a shaft or repair the locking mechanism, the entire gear box must be removed, for the shape of the fuselage does not permit room to pull the ratchet shaft out.

8. ARMOR PLATE

On the B-25A airplanes, the tail gunner is shielded by armor plate. Two pieces of armor plate are stationary; one piece being a part of the structure and fastened to the last frame, while the other is removable and lies between the sight and the glass above the sight. There are four other pieces, all of which are attached to movable parts. One of these is attached to the aft side of the gimbal on bosses provided. Two pieces, right and left-hand parts, attach to the clam shell doors and their crescent shaped hinge arms. The remaining piece is attached to the gun barrel by means of a casting to which the armor plate is bolted.

ADDENDUM II

Items peculiar to B-25B Airplanes only.

1. NOSE GUN

The armament on the B-25B airplanes consists of one .30 caliber, model M-2, machine gun which can be flexibly mounted in the nose and two electrically operated gun turrets each mounting two .50 caliber, M-2, machine guns. The armament on the B-25C airplanes differ from that on the B-25B only by the ball and socket gun mount in the nose. A new type (Fig. 2) of ball and socket mount is installed on the B-25C airplanes. All ball and socket gun mounts (Fig. 7) are similar on the B-25, B-25A and B-25B airplanes and have been described previously in Fig. 6.

ADDENDUM III

Items applicable to all B-25 Series Airplanes.

1. TARGET TOWING EQUIPMENT

The B-25 airplanes contain facilities for the installation of target towing equipment. This equipment is installed within the airplane bomb bay and can be put into place without removing any of the regular bomb installations. The towing equipment consists of three (3) main installations and several smaller units, all bolted into place.

The first of the three main units is the truss assembly;a welded steel tube structure upon which is mounted a type C-5 electric rewind equipped tow target windlass. This windlass bolts on to the upper cross members of the truss with eight one-quarter (1/4) inch bolts and elastic stop nuts. The windlass has a capacity of seven thousand (7000) feet of one-eighth (1/8) inch flexible cable. The truss is installed in the bomb bay of the ship before the special windlass is mounted on it. This simplifies the installation because the truss and windlass as a unit are too heavy and cumbersome to install with ease.

The castings that are on the ends of the cross members of the truss assembly have matching holes in the forward bomb rail and in the inner flange of frames No. 224 (the first frame forward of the bomb rail). The matching holes in the forward bomb rail have anchor nuts backing them so the cover plates on the rails need not be removed. Once the truss is installed, the windlass can be put into place with the handle to the right and facing aft and upward at an angle of approximately thirty (30) degrees. This angle can be checked by noting that the lowest hole in the aft fittings match with the end holes of the windlass. The electrical plugs should next be connected to the socket on the forward bulkhead provided for this purpose.

After the truss assembly and windlass have been securely bolted into the airplane, the next step is the installation of the air ducts. These ducts are provided to cool the brake band of the type C-5 windlass. To accomplish the cooling operation an air scoop is extended from the bottom of the fuselage into the air. Air passes through the scoop and into duct assembly which extends up the left side of the windlass passing between the tubes of the truss assembly. Three separate tubes make up the air duct assembly. They telescope into one another and are fastened together by machine screws. It should be noted that the scoop has a screen cover at its opening installed to prevent damage from flying particles during landings and take-offs. The screen is installed on the scoop before the air duct assembly is put on the airplanes.

The third step in this installation consists of putting the floor assembly in place. Remove the supporting castings on one side

of the floor structure and bolt them to the corresponding longerons in the ship. The floor is placed in the ship by rotating it slightly to allow the fittings remaining on the floor to rest on the top side of the lower longeron and matching the holes of the fittings with the holes in the longeron. The aforementioned fittings which were taken off the floor and bolted to the corresponding longeron are then bolted to the floor and the remaining two fittings left on the floor structure are bolted to their corresponding longeron.

The pulley support should be bolted inside the truss box with the fairlead socket facing aft. Bolt the fairlead support to the fitting provided on the bottom of the floor and install the fairlead. To complete the installation bolt the bomb door stop to the bracket on the forward end of the right hand door. Stringing up the cable and target is done to suit the one installing the equipment.

Operation of target towing equipment is in accordance with technical orders No. 11-40-15. The operator rides in the bomb bay seat provided in the floor structure. While in flight the operator gets to his seat through the man hole in the passageway floor. Bomb bay doors should be kept closed until the operator is ready to let out his target. He should drop the target through the hatch in the floor with the windlass brake off so that target will clear ship quickly. Operator may then resort to regular target towing methods.

It should be noted that in cases of emergency the operator should cut the cable at the fairlead end and if necessary use the opening provided in the floor for an escape hatch.

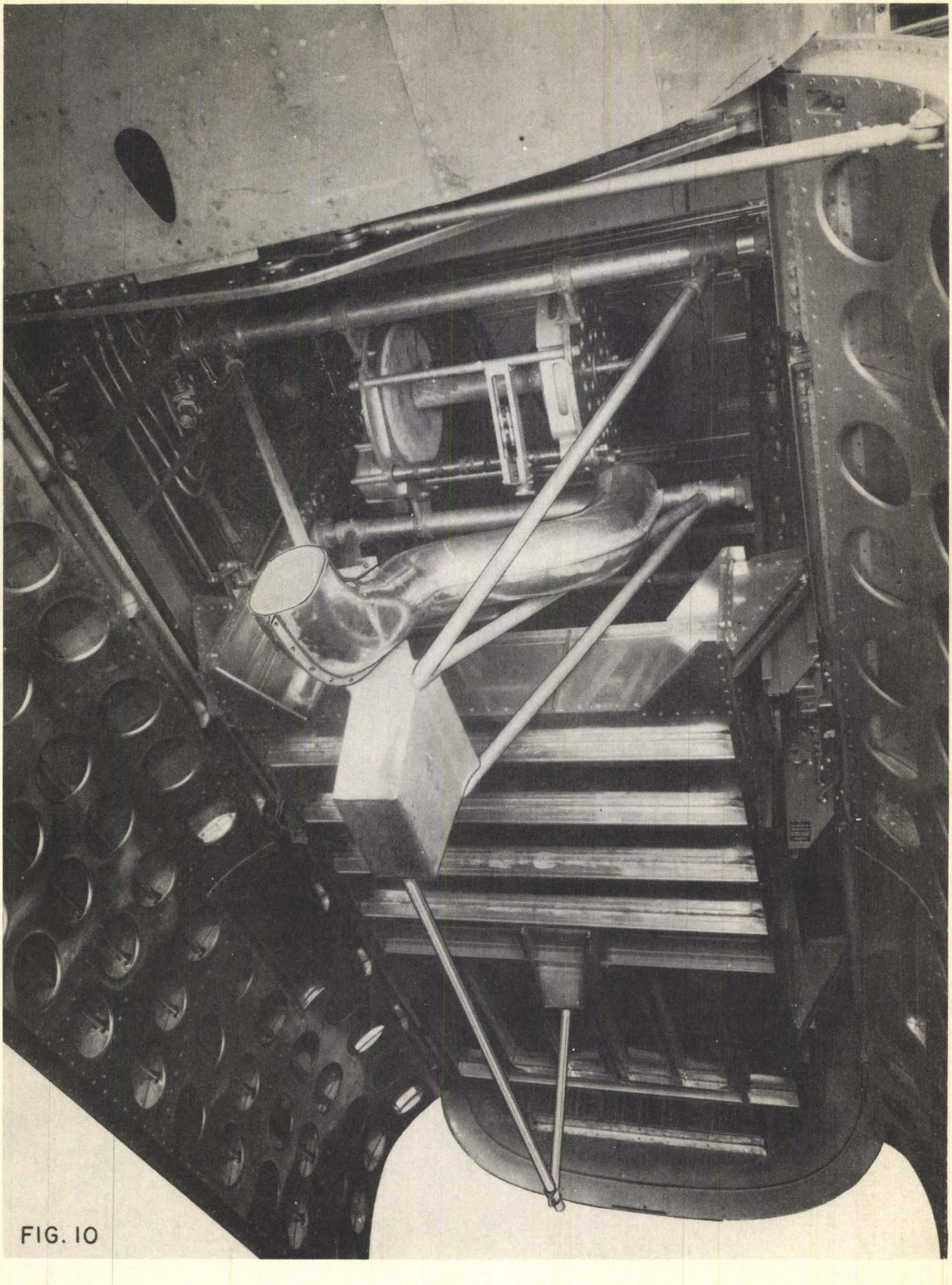


FIG. 10

SURFACE CONT.

NORTH AMERICAN AVIATION Inc.

Surface Controls LECTURE

B-25 SERIES AIRPLANES

PREPARED BY Fred Prill

NOTE

THE INFORMATION CONTAINED IN THIS LECTURE WAS CORRECT AS OF MAY 15, 1942. REFER TO HANDBOOK OF OPERATION AND SERVICE INSTRUCTIONS FOR THE LATEST INFORMATION.

THIS DOCUMENT CONTAINS INFORMATION AFFECTING THE NATIONAL DEFENSE OF THE UNITED STATES WITHIN THE MEANING OF THE ESPIONAGE ACT, 50 U.S.C., 31 AND 32. ITS TRANSMISSION OR THE REVELATION OF ITS CONTENTS IN ANY MANNER TO AN UNAUTHORIZED PERSON IS PROHIBITED BY LAW.

N A A

INGLEWOOD, CALIFORNIA

I N D E X

ILLUSTRATIONS

GENERAL

The surface controls of the airplane consist of elevator, rudder, aileron, flap, and locking and trim tab operating mechanisms. Since the flaps are operated by hydraulics and will be covered by that group, only the cable equalizing and mechanical lowering system will be taken up here. The system is designed for an arbitrary load of four hundred fifty (450) pounds applied to the cockpit elements (up to the stops) except tha aileron, which is governed by the hinge moment of the control surface. It is designed strongly enough so that the combined effort of both pilots (nine hundred pounds) can be taken down either side of the duplicate system. A cable system is used primarily because initial tension can be obtained by tightening the turnbuckles and consequently eliminating play in the system. By initial tension we mean the rigging load.It is required by Air Corps Handbook that this tension be great enough so that when one-half (1/2) of the limit load is applied to the control surfaces, the return cables will be just slack. It is also required that when the design load is applied to the surface, the latter will not deflect over fifteen (15) degrees with the cockpit elements remaining fixed.

The cable size and its movement is governed by the latter condition; by increasing the travel, the load and consequently the stretch is reduced. It may be noted here that by increasing the initial tension of the system the relative deflection between surfaces and control elements is not reduced. Another element that enters is the fact that the aluminum alloy airplane and stainless steel cables do not expand and contract at the same rate. For a temperature range of one hundred fifty (150) degrees, this difference is approximately one-eighth (1/8) inch per ten (10) feet of length; the cable getting slack at low temperatures and tight at high temperatures.

A duplicate system is used on the aileron,rudder and elevator. On the aileron all controls in one wing can be disconnected without affecting the operation of the aileron in the other wing. On the rudder, any one element can be disconnected but at least one rudder will still operate. On the elevator, one element can be disconnected without losing the operation of the elevator. In most cases several elements may be disconnected without losing the use of the surfaces.

The cables are 7 x 19 preformed stainless steel, 3/16 inches in diameter for main cables,1/8 inch in diameter for A.F.C.E.cables; and 7 x 7 preformed stainless steel, 1/16 inch in diameter for trim tab controls, 3/32 inches and 1/16 inch in diameter for lock controls.

For comment on tinned steel cable see page 25.

Turnbuckles are used for taking up cables and are of the long type except in very short runs where the short type is used. Swaged type turnbuckle ends are used throughout.

The swaged type are used in preference to the spliced end type as they are smaller and do not have projecting bolts which can catch on frames, etc. The turnbuckles are within a tolerance of three (3) threads out, to four (4) threads in, when leaving the factory. This leaves considerable take-up for field service,due to the wear of the pulleys, etc.

Pulleys are A. N. standard, made from phenol fibre. Special pulleys are used on the elevator cable at the bulkhead between the bomb sight operator's and the pilot's compartments, and at base of the control column. This is due to the high loads. For bends over thirty (30) degrees, large diameter pulleys are used (AN210-2A and 4A) and under thirty (30) degrees, small diameter pulleys are used (AN210-1A and 3A); the load ratings of all pulleys are given on AN210 Drawing. Due to the low load rating of the pulleys a new standard is being considered. A cable is allowed to be out of line from a pulley one (1) degree on a fixed pulley, and two (2) degrees on a pulley whose cable moves up and down as from an arm, providing it is only one (1) degree in neutral position.

For deflecting cables through small angles, and to prevent them from vibrating against the sheet metal frames, phenol fibre fairleads are used. These angles of deflection are two (2) degrees up to fifty (50) pounds rigging load, and one (1) degree from fifty (50) to one hundred fifty (150) pounds rigging load. Many of the fairleads have a diagonal slot in the edge for inserting the cable when the latter is slack.

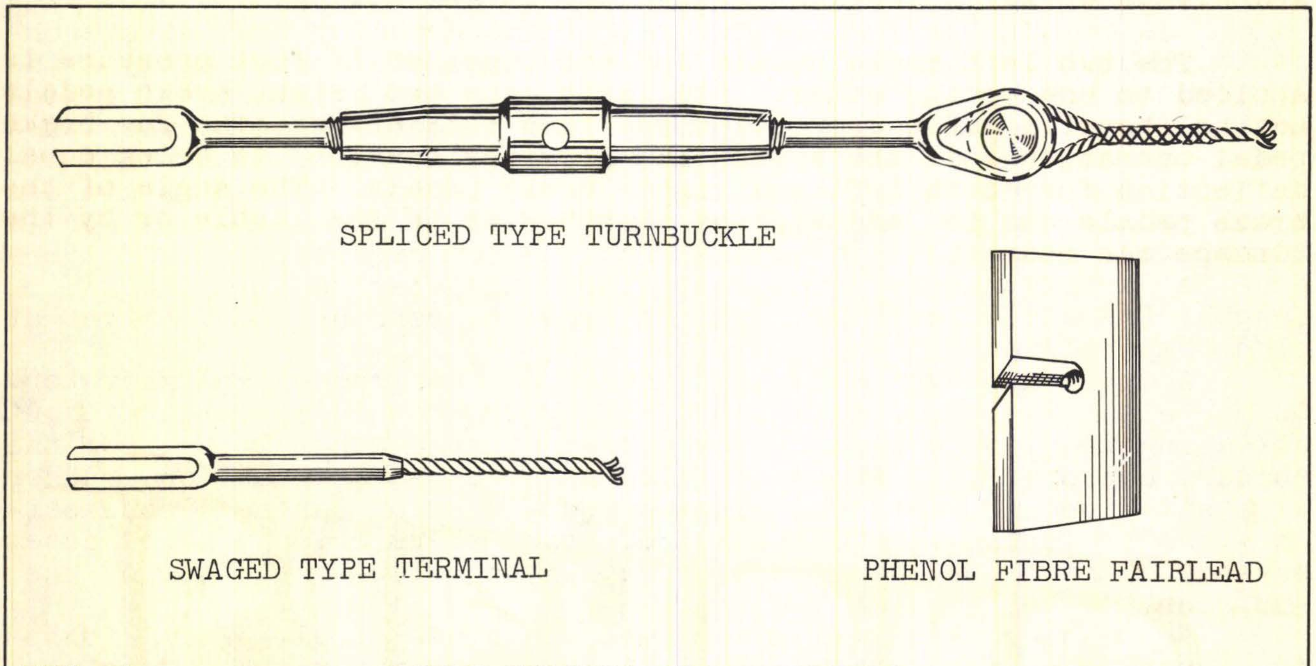


FIG. 1 CABLE SWAGING AND FAIRLEADS

RUDDER AND BRAKE SYSTEM

The twin rudders of this airplane are operated from hanging type rudder pedals. There is no fore and aft adjustment of the pedals as this is accomplished by moving the seat either fore or aft to attain proper leg position. The maximum movement of the pedals is six and one-half (6-1/2) inches at foot level.

The rudder pedals (A,B,C,D), Fig.2, are forged aluminum alloy, and are mounted on a steel torque tube (E) which is supported at the ends in an oilite bearing which requires no lubrication. Grease fittings are provided on those moving parts requiring lubricant.

The rudder pedals (A) and (C) are connected together ana (B) and (D) are connected together by means of a steel jumper torque tube. Thus, movement of (A) will also actuate (C), both moving forward or aft at the same time, and similarly, movement of (B) will actuate (D).

The brake pedals (F) are aluminum alloy castings, which remain at approximately an angle of ten (10) degrees to the vertical through the total throws, and deflect thirty (30) degrees for full brake. These pedals (F) are connected to linkage tie rods (L) and thence to levers (G-H-I-J) supported on the rudder pedal torque tube. A cable transmits brake pedal motion from (G-H-I-J) to the hydraulic brake control valve which is located in the forward end of the nose wheel well. There is a heavy spring at the control valve to give feeling to the brake and bring the pedals back to position after foot pressure is relieved. There is also a stop incorporated at the valve, to limit the travel and take excessive foot loads when the pedal has reached the limit of its travel. A light spring (K) is provided on each pedal linkage to pick up slack in cables to the brake valve spring and always works in tension against the larger spring.

The two left brake pedals deflect together if foot pressure is applied to one or the other. Similarly, the two right brake pedals act as above. A cable connection provides this arrangement for brake pedal operation and the spring (K) provides tension to bring equal deflection for both left and right brake peaals. The angle of the brake pedals can be adjusted by turnbuckles in the cable or by the linkage tie rods (L).

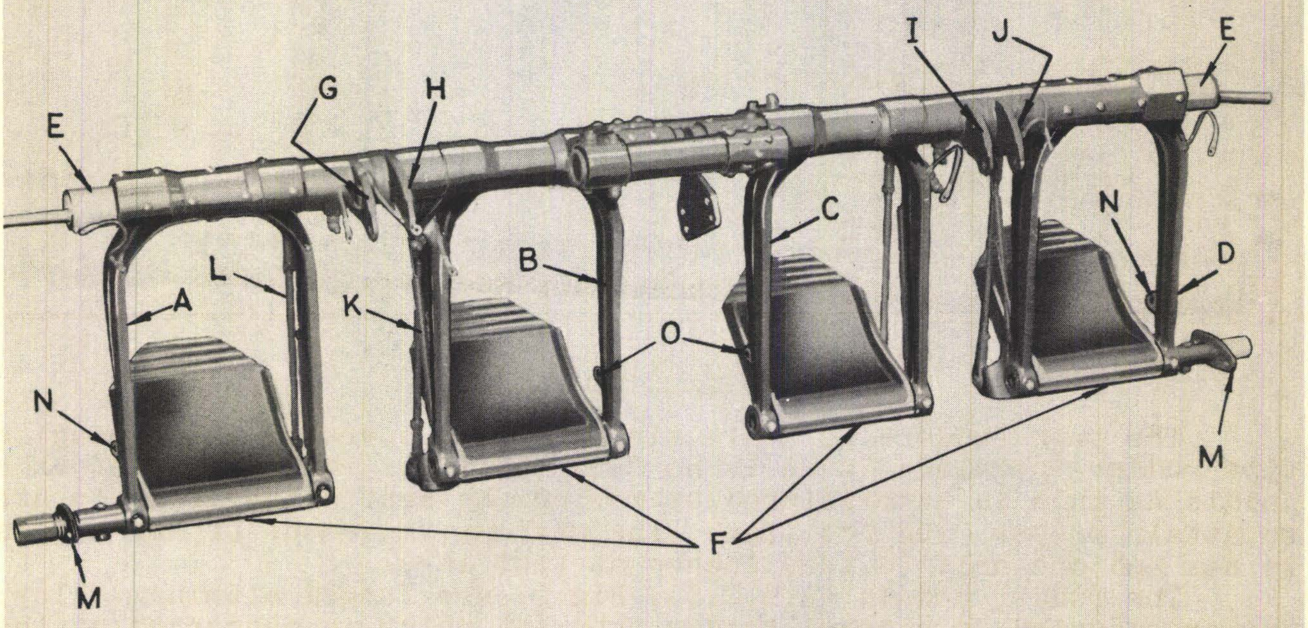


FIG. 2 RUDDER - BRAKE PEDAL ASSEMBLY

CONTROL COLUMNS

The control columns, Fig. 3, are located between pilot's and co-pilot's legs and are connected with a steel torque tube (A) running across the ship to the cable take-off horns (B) at each side. The columns are nonmagnetic due to the proximity of the compass. The elevator cable take-off horns are aluminum alloy forgings with adjustable stops located on the fuselage. The wheel is cast aluminum alloy with a moulded rubber coating. Provisions are made for two microphone buttons and two trigger switches in each wheel.

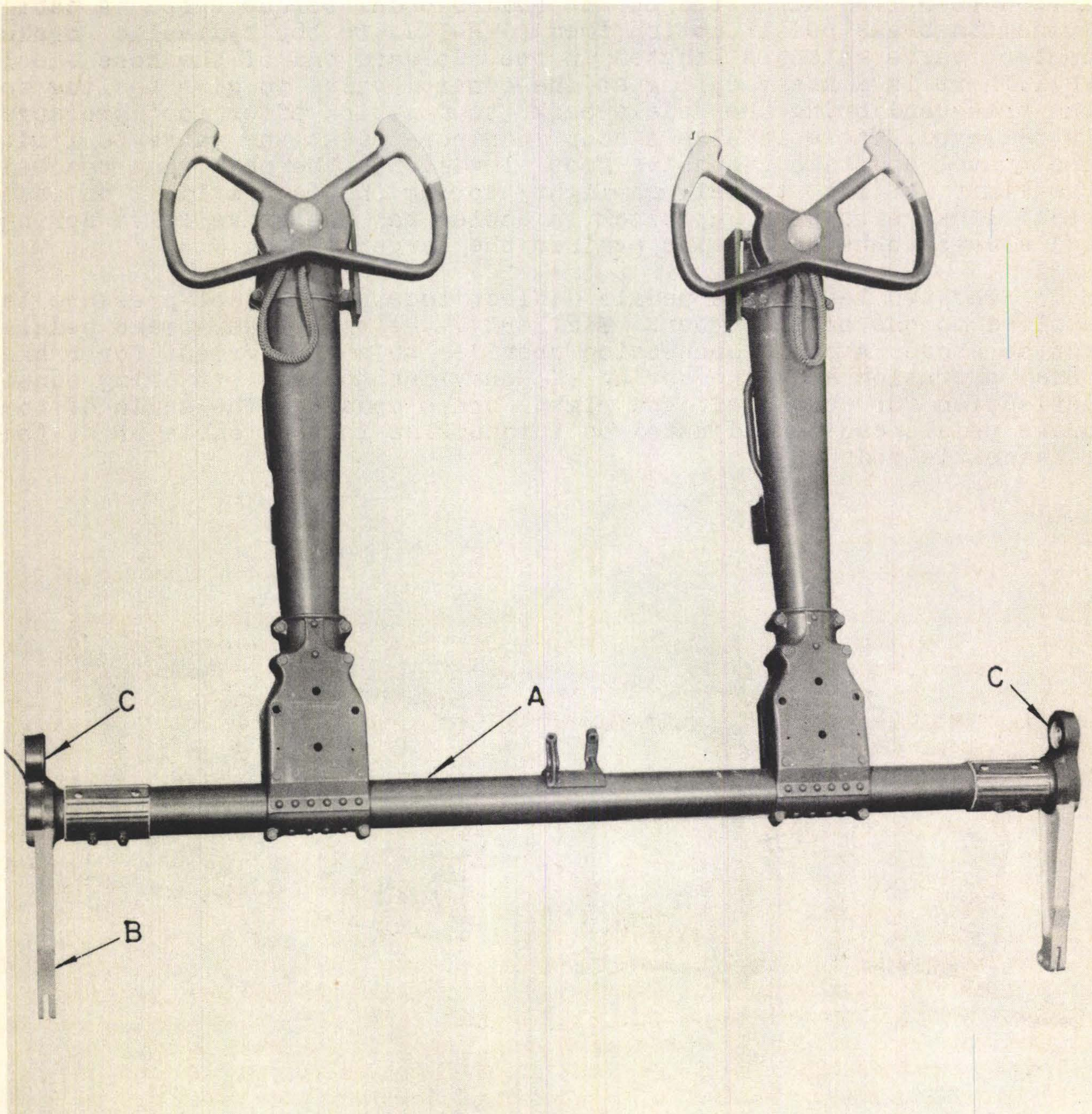


FIG. 3 CONTROL COLUMNS

The aileron cables are controlled by movement of the wheel in a clockwise or counter-clockwise direction. The chain drive sprocket (A), Fig. 4, is mounted on the control wheel shaft (B). The sprocket is of cast bronze and is mounted between two self-lubricated ball bearings. The sprocket has seventeen (17) teeth and with the control wheel travel of one hundred eighty-three and one-half (183-1/2) degrees each side of neutral transmits three and three-sixteenths inches travel each way to the chain and cables attached to it. A stop (C) is mounted on the control wheel shaft next to the sprocket (A). The slotted stop (C) consists of two parts, one being the pin (D) threaded into the shaft and moving inside the slot (E) of the second part.

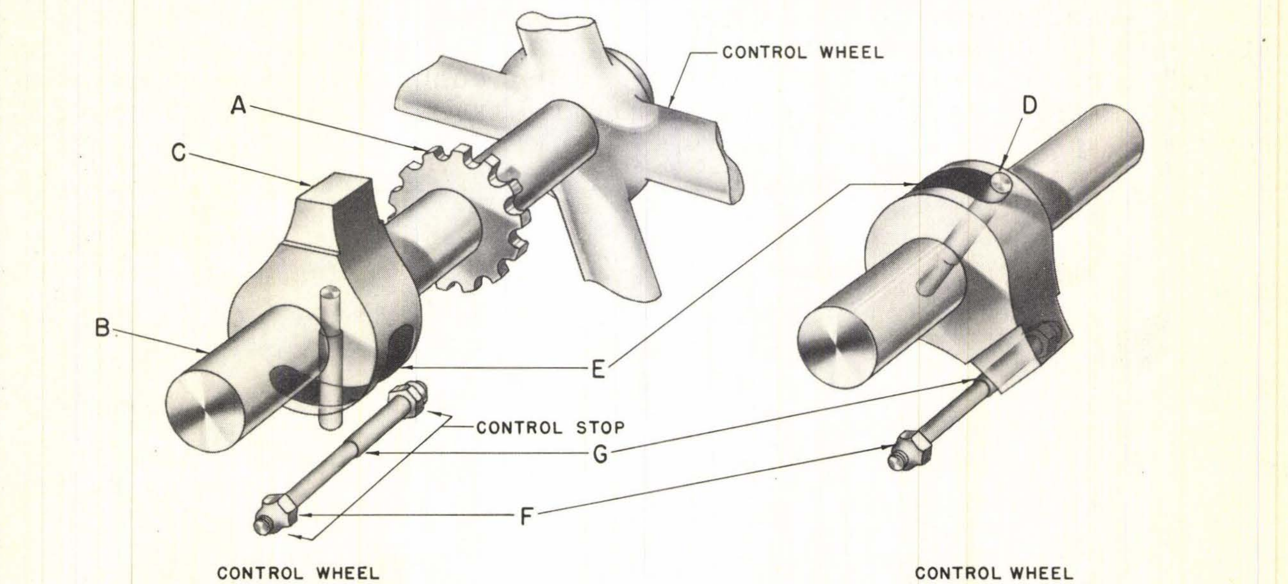


FIG. 4 CONTROL WHEEL DETAIL

Rotation of the control wheel left or right will engage the stop (C) against the control stop bushing (G). The control stop bushing (G) is replaceable and is mounted on the bolt (F). All parts of the stop are of K monel metal. This double stop allows a wheel movement from one hundred eighty-two (182) degrees to two hundred seventy (270) degrees by changing the number of teeth on the sprocket (A) and using a longer slot (E). The cable travel of three and three-sixteenths inches moves the ailerons up thirty (30) degrees and down fifteen (15) degrees.

The chain which passes over the sprocket (A) is of stainless steel with one-half (1/2) inch pitch, five-sixteenths (5/16) inch wide and three hundred twelve thousandths (.312) inch diameter rollers. The aileron cables are bolted to special fittings and lead out each side of the steel torque tube to their respective controls. There is a removable cap on top of the control column to remove the chain or lubricate it with graphite grease. The aileron cables can be disconnected from an access hole on the forward side of the swaged portion of the control column. The sprocket shaft and its assembly may be removed by unscrewing the bolts that hold the two halves of the column head together along with the bolts that are screwed into the swaged portion of the column. The control wheel may be detached by removing the nut under the cup on the aft side.

RUDDER OPERATION

The rudder cables leading to the control surfaces take off at the foot level (M), Fig. 2, of the pedals. The cables to the A.F.C.E. going forward are attached to two (2) forged lugs (N), Fig. 2, on the outboard pedals. There is a rudder pedal balance cable, Fig. 5, on an adjustable link going forward from the two (2) inboard pedal forks. There are two (2) jumper cables; a forward one going around the rear of the pilot's seat tracks and an aft one at the front spar of the horizontal stabilizer. The two rudder pedal stops are at the outboard pedals and are adjustable. The locks are in the rudders themselves. The rudder cables are attached to the aluminum alloy cast sheaves and movement of the cable about the sheave actuates the push rod, which is connected to the rudder horn on the forward edge of the rudder surface. The push rod moves fore and aft and in turn rotates the rudder surface left or right thirty (30) degrees.

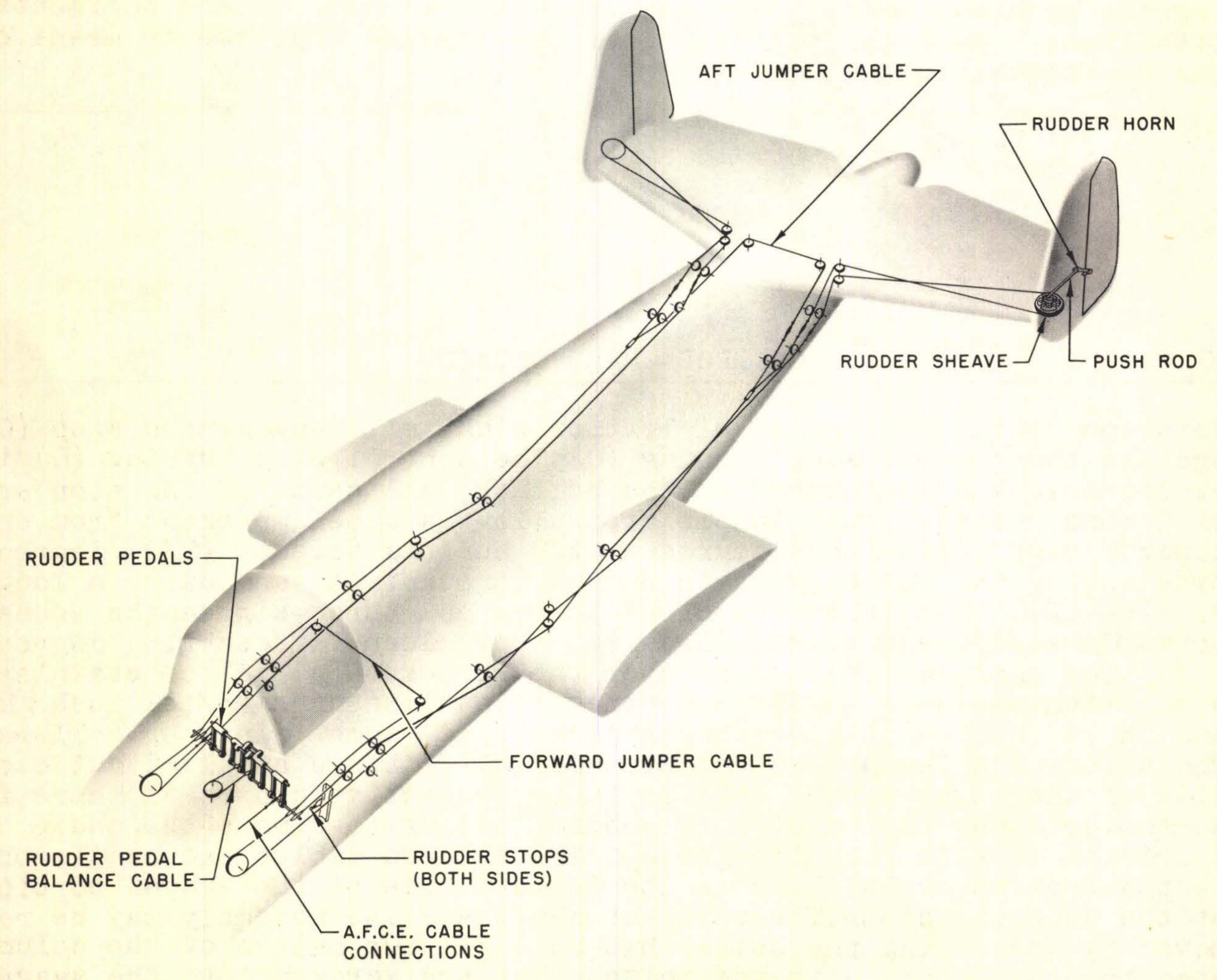


FIG. 5 RUDDER OPERATION DIAGRAM

ELEVATOR OPERATION

The control column moves fore and aft through an angle of forty-two (42) degrees about bearings (C), Fig. 3, as a pivot. The column is in the center of its arc with the elevator surfaces up five (5) degrees with reference to the horizontal stabilizer. The elevator cables are connected to cable take-off horns (B), Fig. 3, on each end of the elevator torque tube. Elevator cable stops are built into each side of the fuselage, Fig. 6, at the cable take-off horns. A.F.C.E. cable connection for the elevator control takes off on the right elevator horn to the fore part of the ship. The elevator cables lead aft to walking beams at the rear end of the fuselage; one on the left-hand side and the other on the right-hand side. The one on the right-hand side has the surface control lock incorporated in it.

From these walking beams push rods connect directly to the elevator horns mounted on the horizontal torque tube. Fore and aft motion of the push rods raise the elevator surface up thirty (30) degrees or down twenty (20) degrees with respect to the horizontal stabilizer. Both elevator surfaces are joined together by means of the horizontal torque tube.

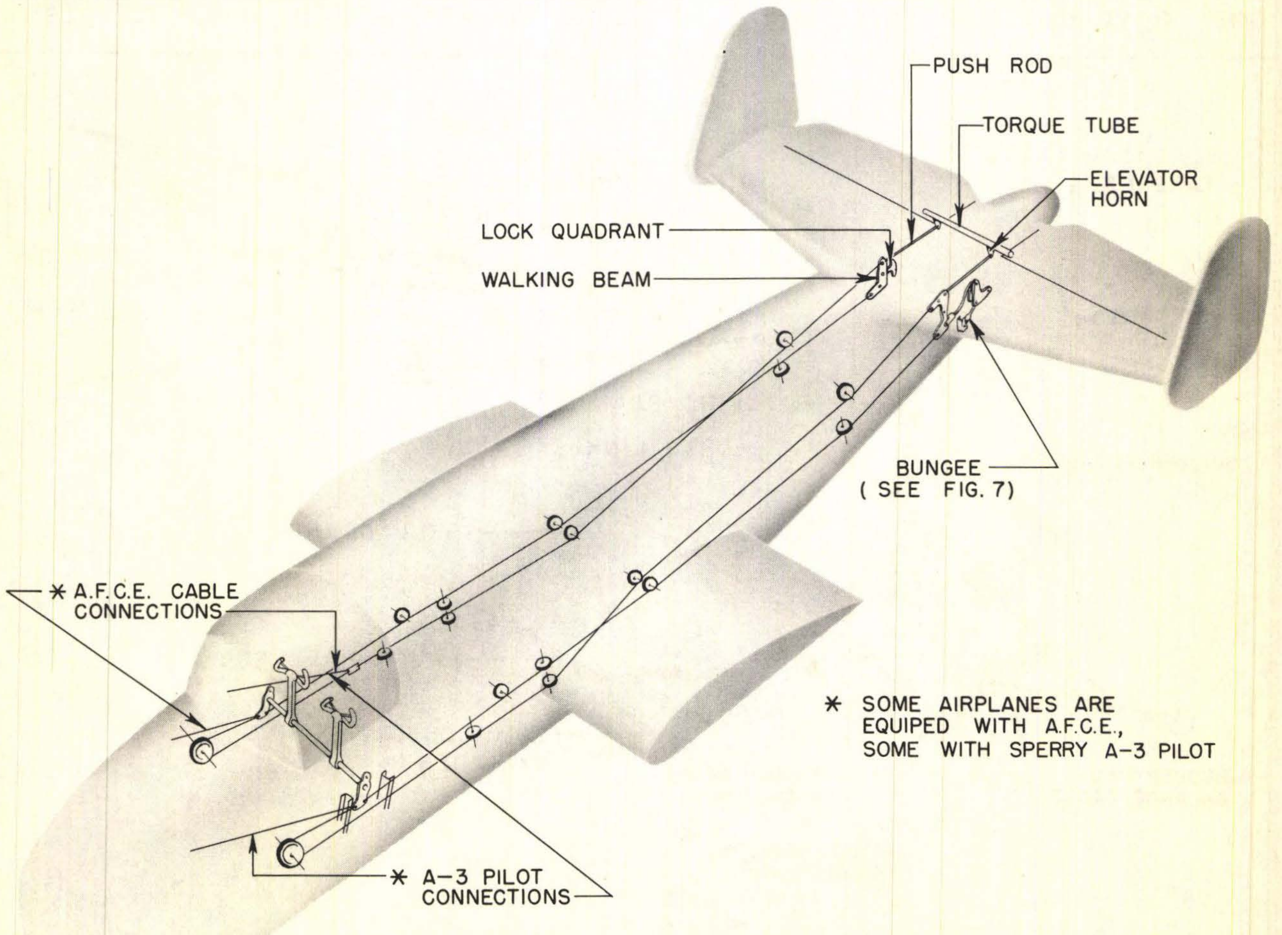


FIG. 6 ELEVATOR OPERATION DIAGRAM

ELEVATOR BUNGEE

The elevator system has a bungee, Fig. 7, which ties into the system at the lower arm of the left rear elevator walking beam.

The elevator bungee consists of a cylinder with a piston, which is actuated by a compression spring and is connected, by means of a push-pull rod, to a bellcrank located so as to give the proper load at the desired elevator positions. The bellcrank is then connected to the elevator walking beam by means of a drag link.

The purpose of this bungee is to correct for the excessive rearward position of the C. G. of the airplane. This is accomplished by the piston of the bungee acting upon the bellcrank in such a manner as to produce a down elevator load when the elevator is near its neutral position. This down elevator load may then be balanced out by the pilot by use of the elevator trim tabs.

The pilot trims the elevators to fly the ship level at the rate of speed he wishes to fly. This means that the trim tabs will be down, pushing the elevator up against the action of the bungee.

If the airplane goes into a glide or dive the speed increases, thus increasing the air load on the trim tab which pushes the elevator up farther pulling the airplane out of the glide or dive.

If the airplane goes into a climb the speed decreases, decreasing the air load on the trim tab, which allows the elevator to come down due to the bungee action, thus leveling the airplane.

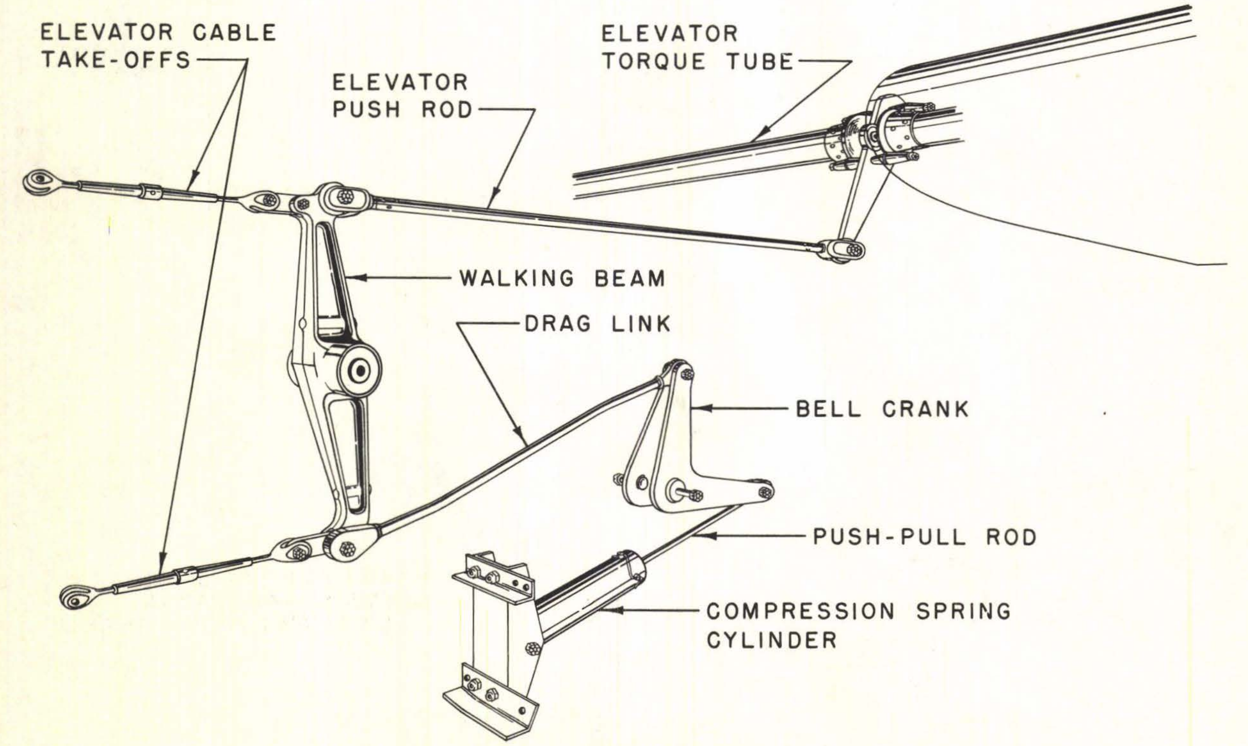


FIG. 7 ELEVATOR BUNGEE SYSTEM

AILERON OPERATION

The aileron cables take off each end of the chain on the control column sprocket, Fig. 8, and are led out of the control column torque tube on each side of the ship. A.F.C.E. take-off connections are also provided at this point and lead to the fore part of the ship. Two aileron cables lead aft on each side of the ship to an aileron sector assembly located on the rear spar of the wing. The cables attach to the aft cast aluminum sector of this assembly.

This sector is attached to a torque tube on the fore end of which is attached a second sector. This second sector delivers motion to the cables leading off left and right on the aft side of the rear wing beam and are attached to their respective aileron control sheaves. Rotation of the sheave delivers fore or aft movement to the aileron push rod. The push rod is connected to the aileron at the inboard hinge bracket so that a differential movement of three (3) to one (1) is obtained on the aileron surface. A cable movement of three and three-sixteenths (3-3/16) inches each side of neutral delivered by the control wheel will move the aileron surface up thirty (30) degrees and down fifteen (15) degrees. The aileron lock is also incorporated in these sheaves.

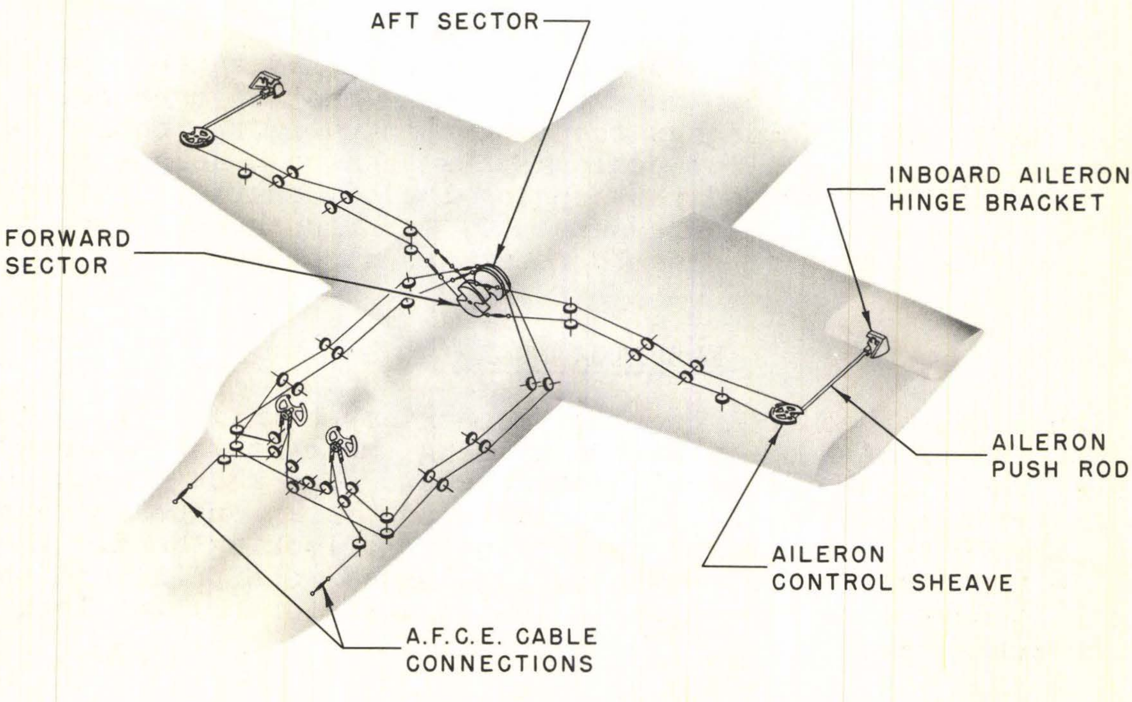


FIG. 8 AILERON OPERATION DIAGRAM

LOCKING SYSTEM

A locking system has been incorporated in the airplane to lock all control surfaces with a single control located in the pilot's compartment, Fig. 9. The lock operating handle is on the floor in front of the pilot's control column. When unlocked it folds up and is out of the way. To lock the controls the sheet metal part of the handle is pulled to the right, then swung forward as far as it will go. This motion delivers rotation to the bellcrank, and the cables taking off at this bellcrank deliver motion to all the surface control locks. The pilot's lock handle should now be pushed down to insure locking the pin in the ratchet below. The surface elements should then be centered until they all lock into position. The handle of the lock now lies across the pilot's right pedal making it difficult to get a foot on the latter. (NOTE: This handle should not be used as a foot brace to push back the seat.)

The locking system consists of the aforementioned handle and a cable operating system to each of the respective locking units. A locking unit is located at each of the control surfaces except the two elevators which have only one to lock both surfaces.

RUDDER LOCKS

The Rudder Control Locks are located in the vertical stabilizers. The rudder lock mechanism for the left rudder is shown in Fig. 9.

The lock tongue is spring-loaded and mounted on a horizontal shaft (A). Cable connections are shown attached to the bellcrank (B), and to lock the rudder sheave, tension must be overcome on the spring-loaded shaft to engage the lock tongue in the socket (C) of the sheave. When the pilot unlocks his controls releasing cable tension on (B), tension of the spring-loaded shaft (A) disengages the lock tongue from the socket (C) in the sheave. The rudder sheave sector will now be free to rotate as directed.

ELEVATOR LOCKS

The elevator control locking mechanism shown in Fig. 9 is located on the right-hand elevator walking beam at the rear of the fuselage. The elevator control lock consists of a lock tongue mounted on a vertical shaft (A). The shaft and lock tongue are spring-loaded (B). Motion delivered by the pilot's locking handle through the cable (C) must overcome the spring-loaded shaft (A) and engage the lock tongue into the slot (D) on the sector (E) to lock both elevator surfaces.

AILERON LOCKS

The Aileron Control Lock is shown in Fig. 9 and is incorporated as part of the Aileron Control mechanism. There are two locks each located in the wing forward of the aileron surfaces at their

respective aileron sheaves. A spring-loaded lock tongue is mounted on the horizontal shaft (A). Cable connections at (B) and (C), lead to the "Pilot's Lock Control Handle". Tension of the cable on (B) of the bellcrank arm will pull the lock tongue against the slot (D) of the sheave thus locking the aileron surfaces. When the tension on (B) is released the spring-loaded shaft will disengage the tongue from the slot (D) and unlock the aileron control mechanism.

It can be seen from the foregoing description of the locking system, that the cables and the "Pilot's Lock Control Handle" form a complete circuit to all parts of the ship. In each case the cable has to overcome the spring-loaded lock tongue to lock all the control surfaces. The system incorporates a positive lock in the unlocked and locked positions so the control surfaces could not accidentally lock due to breakage or removal of a spring. The controls can be locked only with the Pilot's Lock Control Handle in the Locked position.

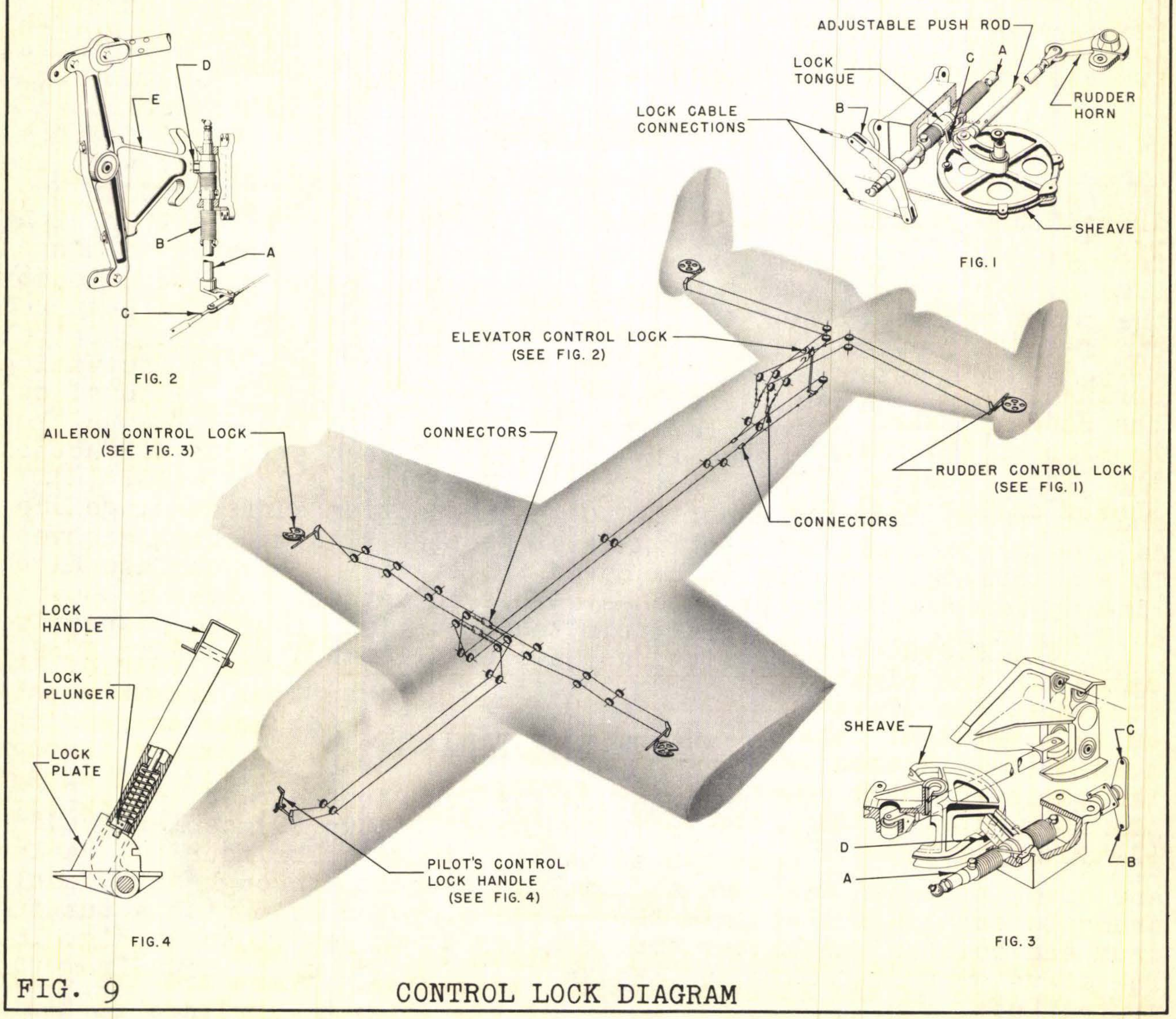


FIG. 9 CONTROL LOCK DIAGRAM

TRIM TAB OPERATION

The elevator trim tab operating wheel is located on the left side of the pedestal engine control quadrant. Rudder and aileron trim tab operating drums are located between the pilot's and co-pilot's seats near the floor. They all lie in the approximate plane of operation. The attitude operating drum is on the left-hand side of the control pedestal below the elevator wheel. All trim tab cable drums have the cable attached by putting the bight of the cable in a slot which cuts across the drum grooves, then inserting the pin and winding cable on the drum from the outside in towards the center. This method allows for a minimum number of grooves because as one side unwinds the other side winds up in the vacated groove.

RUDDER TRIM TABS

The rudder trim tab operating drum located between the pilot's and co-pilot's seats, near the floor,controls the cables leading aft to the rudder trim tab actuating drums. The two cables leading to the rear end of the fuselage are each attached to two cables by connectors and passed by pulleys, one to right rudder trim tab drum and the other to the left rudder trim tab drum. From each trim tab actuating drum the cables pass back and connect to the other cable leading from the pilot's control drum. This system, Fig. 10, of four (4) cables in the rear tie together and form a complete circuit with the two (2) main cables. There is a trim tab for each of the rudder surfaces. The rudder trim tabs move twelve (12) degrees left or right from neutral. Each trim tab is operated by two (2) push rods hinged together at the surface hinge line. The push rods are actuated by the cable drum revolving on the threaded end of the forward push rod. The drum is forward of the center hinge line on each main control surface. A booster ratchet is fitted on each trim tab actuating mechanism. The ratchet fitting is attached to both horizontal and vertical stabilizers for elevator and rudder trim tabs. The ratchet is also fitted to the hinge line forward of each aileron surface on the wing for each aileron trim tab. The fitting has eight (8) V-shaped grooves running parallel to the respective surface hinge line. Adjacent to the ratchet fitting is a bearing with matching grooves. This allows the bearing to be moved relative to the surface hinge line by meshing different notches. This adjustment causes a booster action along with the normal trim tab operation for the respective control surface. Grease fittings are on all parts requiring lubrication.

ELEVATOR TRIM TABS

The two elevator trim tab cables run to the rear end of the ship, Fig. 11, and each cable is connected to two (2) cables leading aft to the elevator trim tab actuating drums. The four (4) cables are tied together and form a complete circuit through both cable drums to each elevator trim tab. The elevator trim tab actuating drum and booster mechanism are similar to those shown in Fig. 10. The elevator trim tabs move twelve (12) degrees up or down from the neutral position.

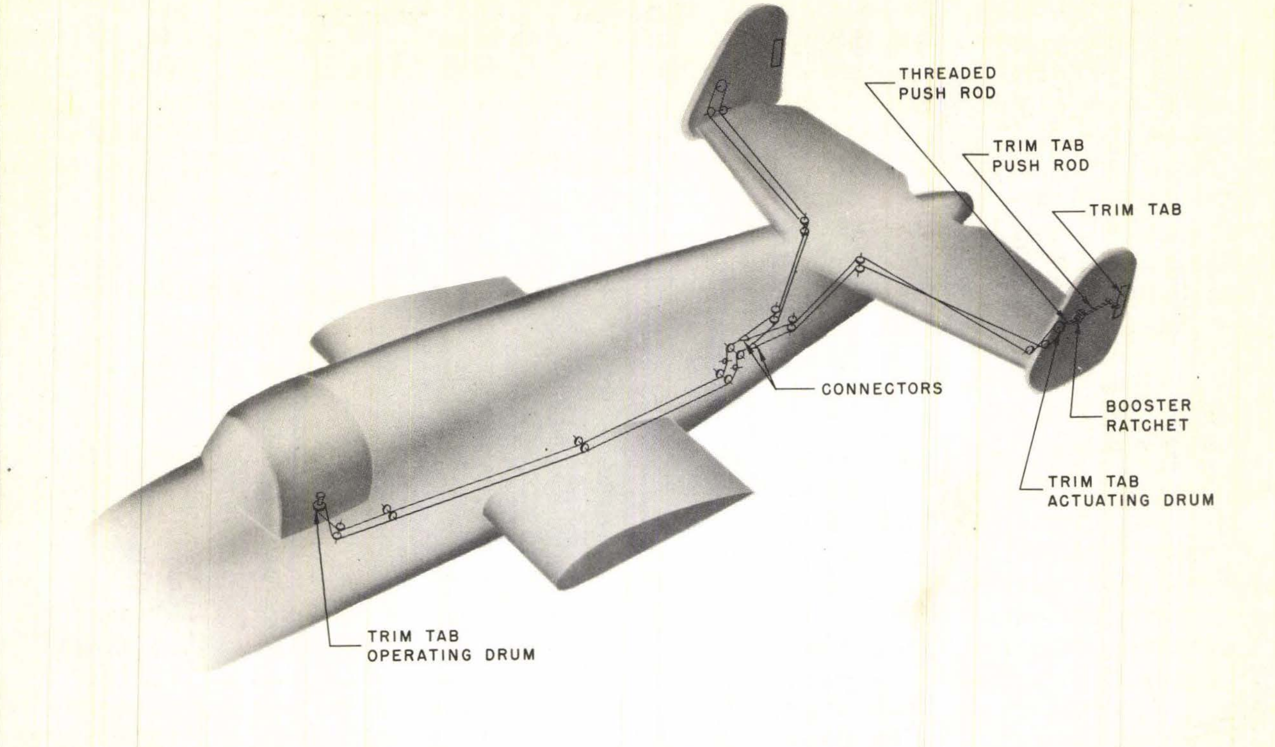


FIG. 10 RUDDER TRIM TAB OPERATION

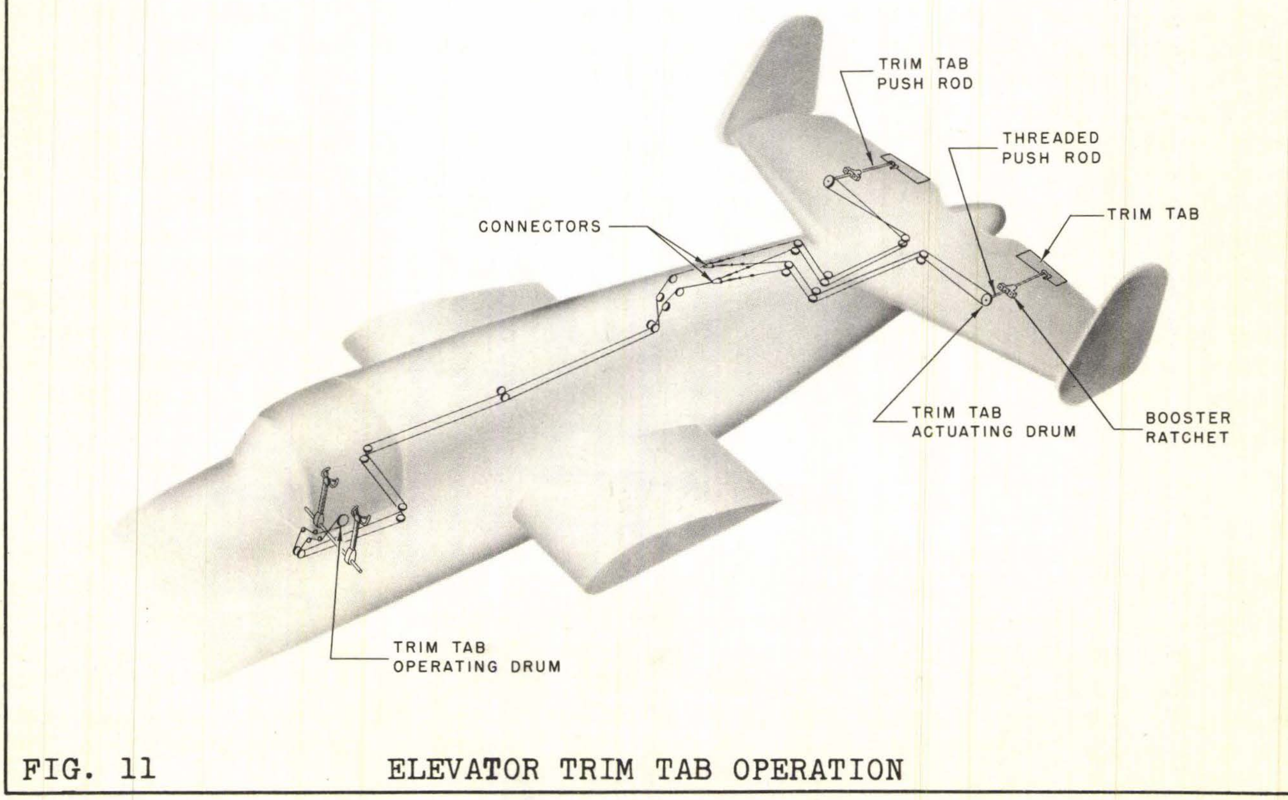


FIG. 11 ELEVATOR TRIM TAB OPERATION

RIGGING DATA CHART

(NOTE: Cable loads as specified below should prevail at approx. 70°F 50)

Surface	Up or Left	Dn. or Right	Cable Loads In Pounds	No. and Location of Turnbuckles	Stops Location
Elevator Sperry	30° 28°	~~30°~~ 20° 18°	Entire System 150 Col. Horn to Link 75	3-Nose Wheel Well 4-Tail of Fuselage	2-Bombar. Tunnel 2-Nose Wheel Well
Rudder	30° In- board 14-15/16"	30° Out- board 14-15/16"	Pedal Balance (30)-90 Fwd. Jumper (70)-40 Aft Jumper 40 Pedal to Rudder 80 Pedal to Aft Link-120 Link to Rudder 80	1-Aft of Co-pilot's Seat 2-R.H. 3-L.H. Aft of Rear Ent. Hatch (2-on Outboard Rudder Pedals)	1-L.H. 1-R.H. at Rudder Control Pedals
Aileron Sperry	30° 28° 9-5/8"	15° 14° 9-5/8"	Wheel to Sector 150 (Link to Sector Only 75 Sector to Ail. 138	8-Aft End Bomb Bay (2-Below Outboard Rudder Pedals)	Fixed
Elevator Trim	~~4°~~ 12°	20° 12°	Wheel to Link 20 Link to Drum 10	4-R.H. in Tail of Fuselage	4-R.H. in Tail of Fuselage
Rudder Trim	1½" In- board	1½" to 1-16/32 Outboard	Wheel to Link 20 Link to Drum 10	4-L.H. in Tail of Fuselage	4-R.H. in Tail of Fuselage
Aileron Trim	13½°	14°	Wheel to Link 10 Link to L.H. Drum 20 Link to R.H. Drum 10	4-Aft End Bomb Bay	2-Each Nacelle
Control Lock	Disengaged		Handle to Fwd. Link 60 Fwd. Link to Locks 20 Fwd. to Aft Link 60 Aft Link to Locks 20	4-Aft End Bomb Bay 6-Tail of Fuselage 2-Each Aileron Lock	Fixed
Flap	0°	45°	Entire System 80	2-Aft End Bomb Bay	1-Each Nacelle
Elevator A.F.C.E. & Sperry Cables			75	2-Nose Wheel Well	
Rudder A.F.C.E. & Sperry Cables			75	1-R.H. 1-L.H. Out'd. of Rudder Pedals	
Aileron A.F.C.E. & Sperry Cables			75	1-R.H. 1-L.H. Below Outb'd. of Rudder Pedals	

AILERON TRIM TABS

The aileron trim tab cables lead from the control drum between pilot and co-pilot and pass to the rear spar of the wing, Fig. 12. The two (2) trim tab cables from each aileron trim tab tie into the two (2) cables by means of links to form a complete circuit. The aileron trim tab actuating drum and booster mechanism are similar to those shown in Fig. 10. The aileron trim tabs operate up thirteen and one-half (13-1/2) degrees and down fourteen (14) degrees.

TRIM TAB STOPS

Adjustable stops have been provided on the cable circuit to limit movement of the trim tab cables. The rudder trim tab system, Fig. 10, has been provided with four (4) stops which are located in the rear of the fuselage. The elevator trim tab system, Fig. 11, has four (4) stops in the rear of the fuselage. These are accessible by removing sheet metal covers on each side of upper rear part of fuselage. (Elevator on right-hand side - rudder on left-hand side.) The aileron trim tab system, Fig. 12, has two (2) stops located in each nacelle.

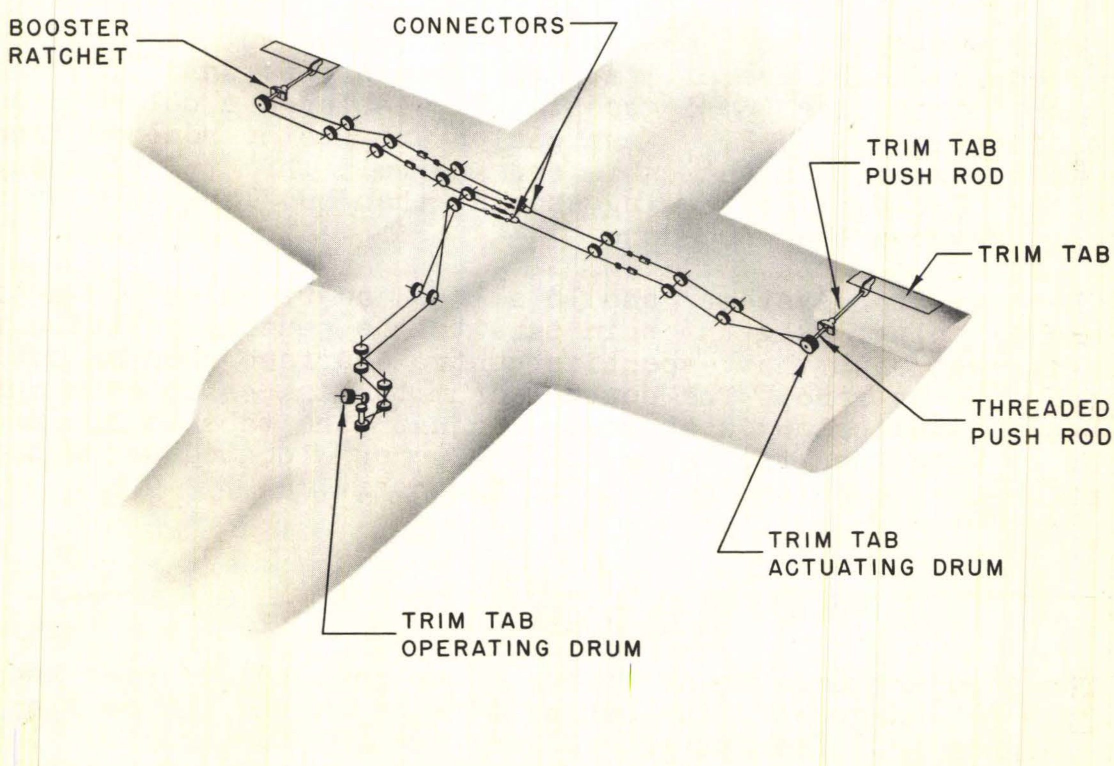


FIG. 12 AILERON TRIM TAB OPERATION

FLAP EQUALIZING CABLES AND MECHANICAL LOWERING

The two (2) flaps, Fig. 13, are tied together by means of a set of three-sixteenths (3/16) inch equalizing cables, the function of which is to make both flaps operate together. These cables are attached to cast magnesium alloy sectors which are bolted to the flap torque tubes, just inside fuselage skin; one on the left-hand and one on the right-hand side. The turnbuckles for adjusting the cables are tied into the mechanically operated emergency wing flap lowering system. The operating unit of the system consists of a gear box unit mounted on the wing center section rear spar. The unit is operated by means of a hand crank, inserted through a small hinged door located on the shelf at the forward end of the radio operator's compartment. When not in use, the hand crank is stowed by means of a strap on the forward bulkhead of the radio operator's compartment. The unit operates two hollow pistons in diverse span-wise directions. Rods attached to the flap equalizer cables move through these gear box pistons when the flaps are operated normally. When it is desired to lower the flaps mechanically, latches on the pistons engage with collars on the equalizer cable rods as the hand crank is rotated in the clockwise direction. A small spring-loaded lever automatically locks the flap lowering mechanism in the desired position as the handle is removed. The mechanism cannot be accidentally engaged during flight with crank in the stowed position.

RIGGING - GENERAL

Cable tensions that are specified throughout the entire rigging procedure should prevail at approximately seventy (70) degrees F. plus or minus five (5) degrees. All cables are color coded as per Specification F. G. 22. When cables are to be removed from the system, tie a string on the cable end and pull the string through to replace the cable. The string should then be labeled. When re-stringing, reverse the procedure.

The trim tab systems should all be adjusted as to entirely eliminate all play. Rig the trim tabs to the neutral position, which is in alignment with the respective control surface when the position indicators are at zero. The control drum to link cable ends must be even when the indicator is at zero. Adjust the tabs to the neutral position by rotating the tab actuating screw located under the tab drum, prior to attaching the drum to the screw.

RIGGING FLAPS

The angular movement of flaps is up zero (0) degrees and down forty-five (45) degrees. The cable tension on the entire flap system is eighty (80) pounds. There are two (2) turnbuckles located in the aft end of the bomb bay. There is one (1) stop located in each nacelle.

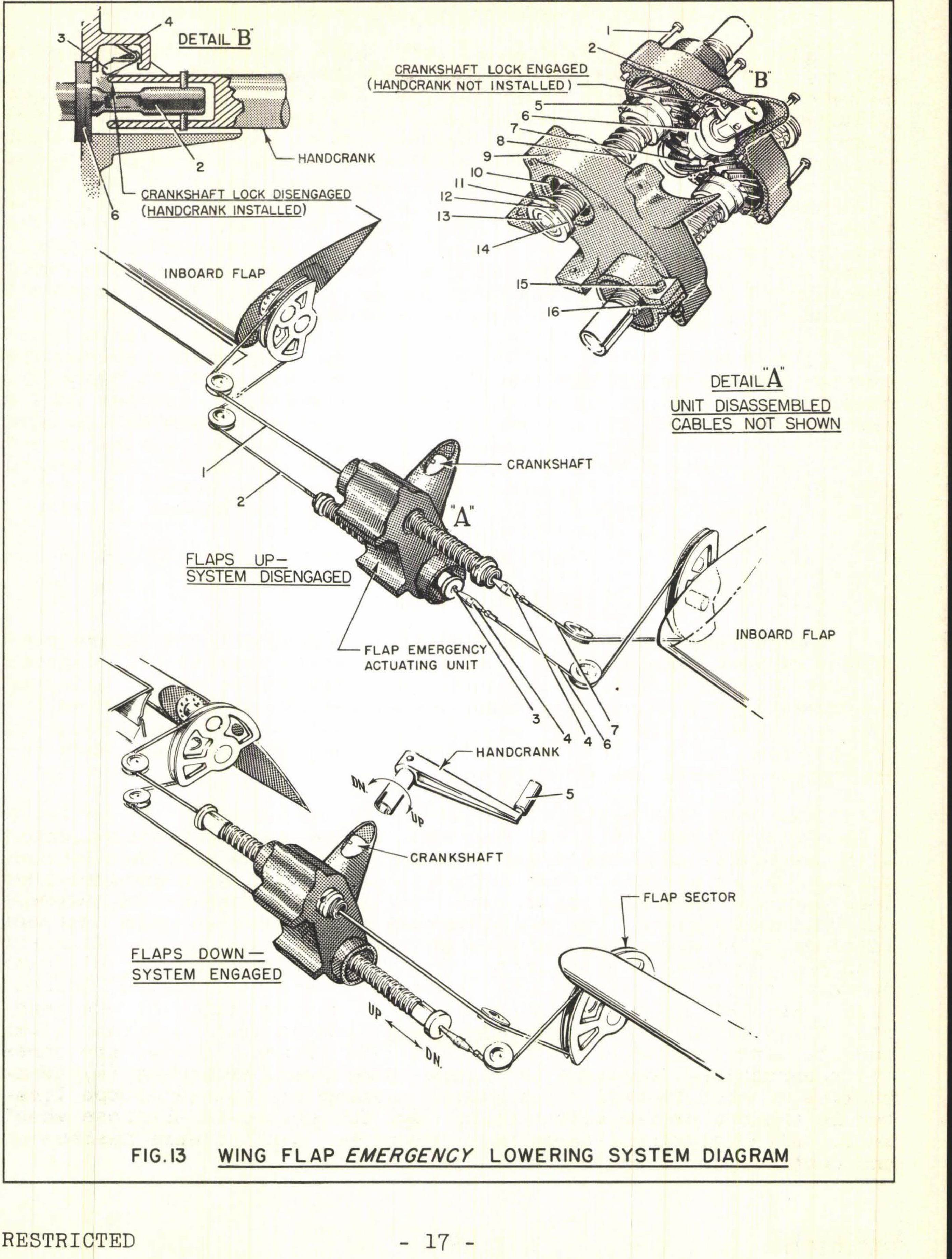


FIG. 13 WING FLAP *EMERGENCY* LOWERING SYSTEM DIAGRAM

RIGGING RUDDERS

With the control lock engaged, adjust the rudder push rods to position the rudders in alignment with the vertical stabilizers. Secure the rudder pedals in neutral, by a bar clamped across forks. Simultaneously rig the pedal balance cable and the forward and aft jumper cables to position the rudder pedals approximately two (2) inches forward of the first bulkhead aft of the pedals, then rig the main rudder cables. The angular rudder movement should be thirty (30) degrees to the left and thirty (30) degrees to the right. The tension on the pedal balance cable, Fig. 14, should be ninety (90) pounds without A.F.C.E.The tension on the pedal balance with A.F.C.E. attached will be thirty-five (35) pounds. The tension on the forward jumper should be seventy (70) pounds with the A.F.C.E. connection and forty (40) pounds without the A.F.C.E.

The tension on the aft jumper cable should be forty (40) pounds. The tension from pedal to rudder should be eighty (80) pounds; and pedal to aft link should be one hundred twenty (120) pounds.The tension from link to rudder should be eighty (80) pounds.

The location of turnbuckles for Rudder Adjustments are as follows:

(1) Aft to Co-Pilot's Seat.
(2) Two (2) on right side and three (3) on left side are found aft of rear entrance hatch.
(3) On outboard rudder pedals.

Rudder stops are adjustable and are located at each outboard rudder pedal.

Re-check all cable tensions.

RIGGING ELEVATORS

With the control lock engaged, rig the elevator in alignment with the horizontal stabilizer when the control columns are secured fifteen (15) degrees forward of a line vertical to the airplane's longitudinal leveling lugs. The fifteen (15) degree measurement can be taken from the face of the control column lower attachment fitting. Elevator travel is taken from the position in alignment with the horizontal stabilizer. The angular movement of elevator surface should be thirty (30) degrees up and twenty (20) degrees down. The cable tensions for the entire system should be one hundred fifty (150) pounds, Fig. 15. The tension from control column horn to link should be seventy-five (75) pounds. There are three (3) turnbuckles located in the nose wheel well and four (4) turnbuckles located in tail of fuselage. There are two (2) stops located in the bombardier's tunnel and two (2) located in the nose wheel well. After rigging ascertain that control column clears instrument and control panels by one-half (1/2) inch.

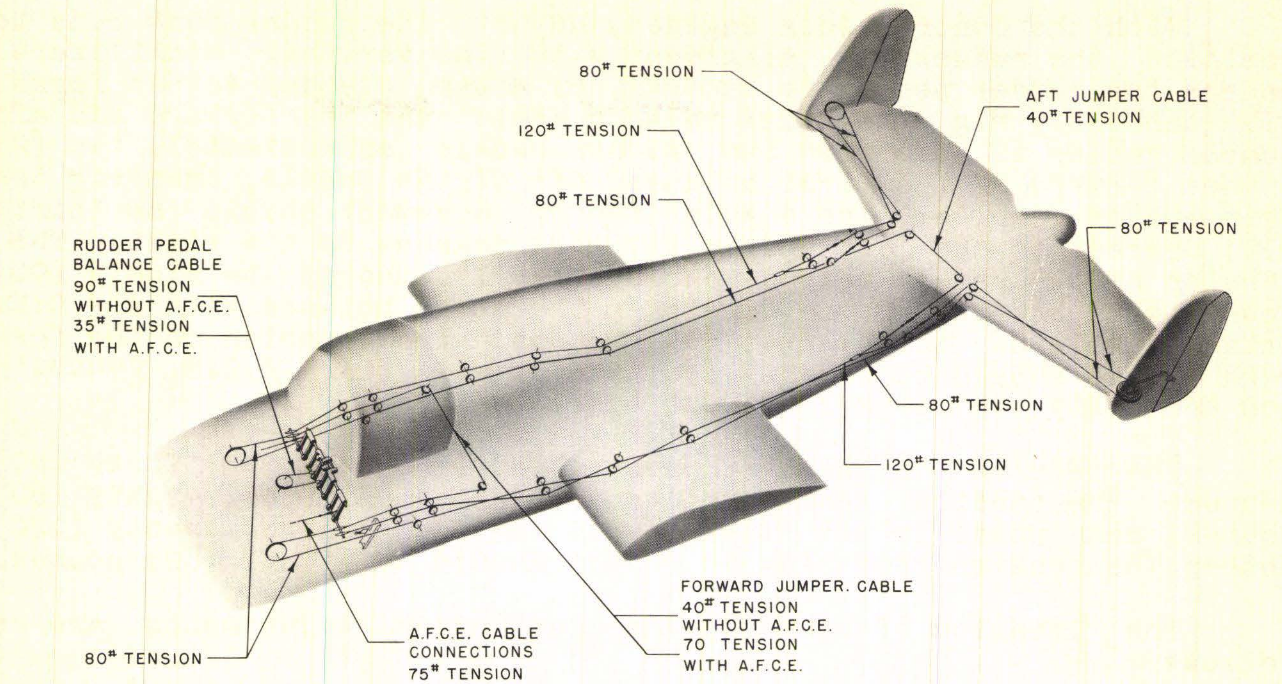


FIG. 14 RIGGING RUDDER CONTROL SYSTEM

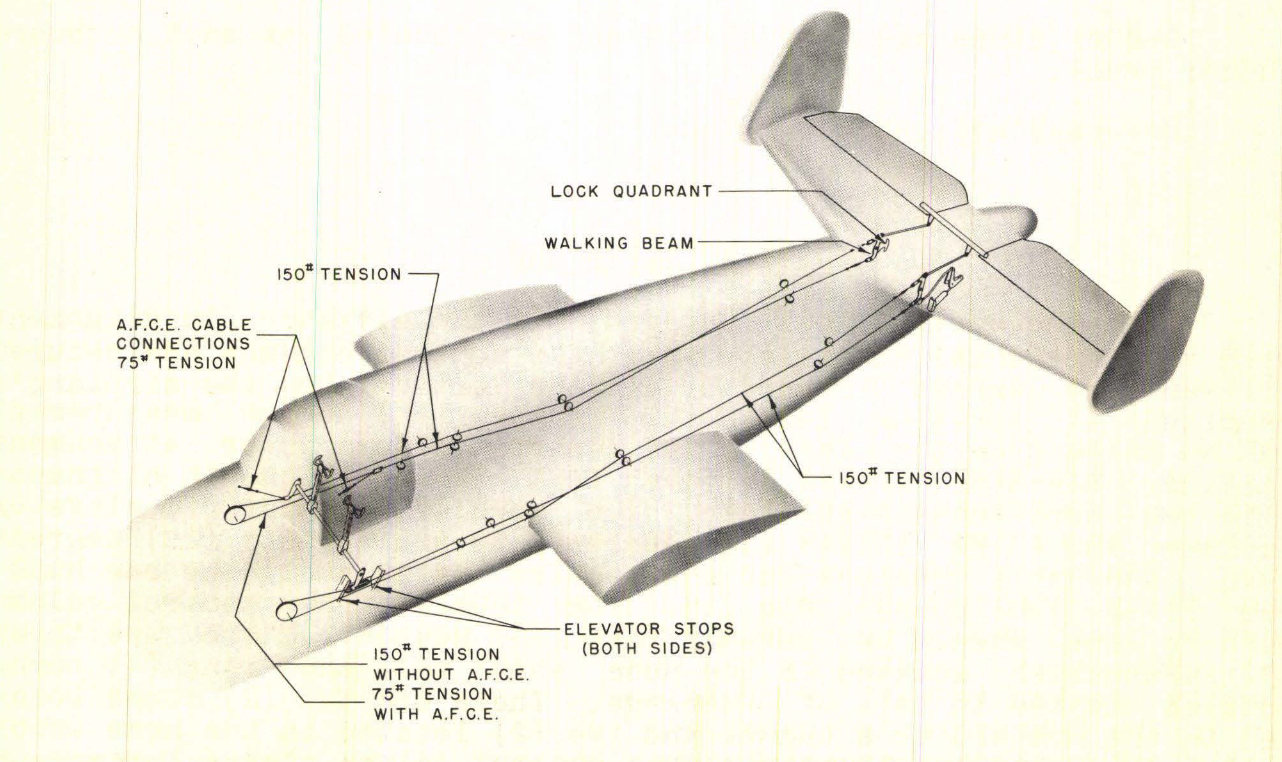


FIG. 15 RIGGING ELEVATOR CONTROL SYSTEM (WITH A.F.C.E.)

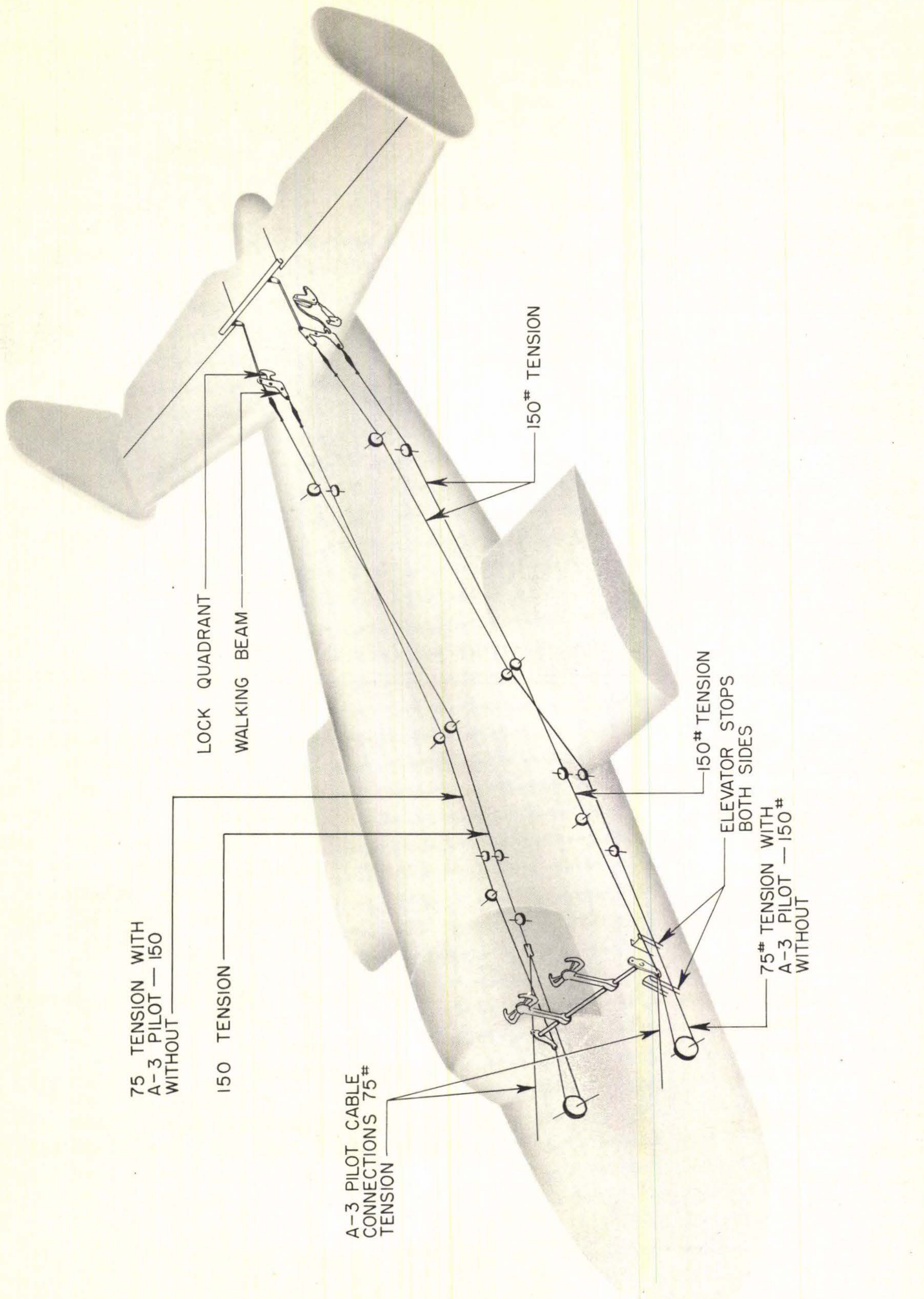


FIG. 16 RIGGING ELEVATOR CONTROL SYSTEM -- A-3 INSTALLATION

RIGGING AILERONS

Turn both control wheels in the same direction and secure them against their stops. Obtain the proper cable tension on the control wheel to sector cables. All cable tensions must be equal. Note the reading in degrees of the sector in relation to the center section rear beam, which is neutral, by placing a protractor level across the lower guard pins on the sector. Turn the control wheels to the opposite side, ascertain that both stops contact simultaneously. Again note the reading in degrees on the sector. Readjust the turnbuckles, as required, to obtain an equal amount of sector movement each side of neutral. Lock the surface controls and ascertain that flaps are in the up position. Adjust the aileron link to position trailing edge of the ailerons in direct alignment with the trailing edge of the flaps when the flaps are in their full up position. Rig the sector to aileron cables, ascertaining that sector is at neutral when ailerons are locked. The angular movement of the aileron should be thirty (30) degrees up and fifteen (15) degrees down, Fig. 17. The cable tension from control wheel to sector should be one hundred fifty (150) pounds. The tension from link to sector with A.F.C.E. tied in should be seventy-five (75) pounds. The tension from sector to aileron should be one hundred thirty-eight (138) pounds. There are eight (8) turnbuckles located in the aft end of the bomb bay and two (2) below the outboard rudder pedals for A.F.C.E. All stops are fixed in the aileron control system.

RIGGING CONTROL LOCKS

Rig control locks in engaged position to firmly seat lock tongues in control sectors. Tighten the four (4) turnbuckles at forward link enough to completely cover turnbuckle threads, and then turn barrel an extra complete turn. Simultaneously rig elevator and rudder locks. Rig engaging cables first, taking up one extra turn on turnbuckles after lock tongues are properly seated, then rig disengaging cables. Rig aileron locks in the same manner. Rigging loads with control lock disengaged are noted on Fig. 18 and are as follows:

Pilot's Lock Handle to forward link - sixty (60) pounds.
Forward Link to Locks - twenty (20) pounds.
Forward to aft Link - sixty (60) pounds.
Aft link to locks - twenty (20) pounds.

The number and location of turnbuckles are four (4) aft end bomb bay, six (6) tail of fuselage and two (2) each aileron lock. All stops are fixed.

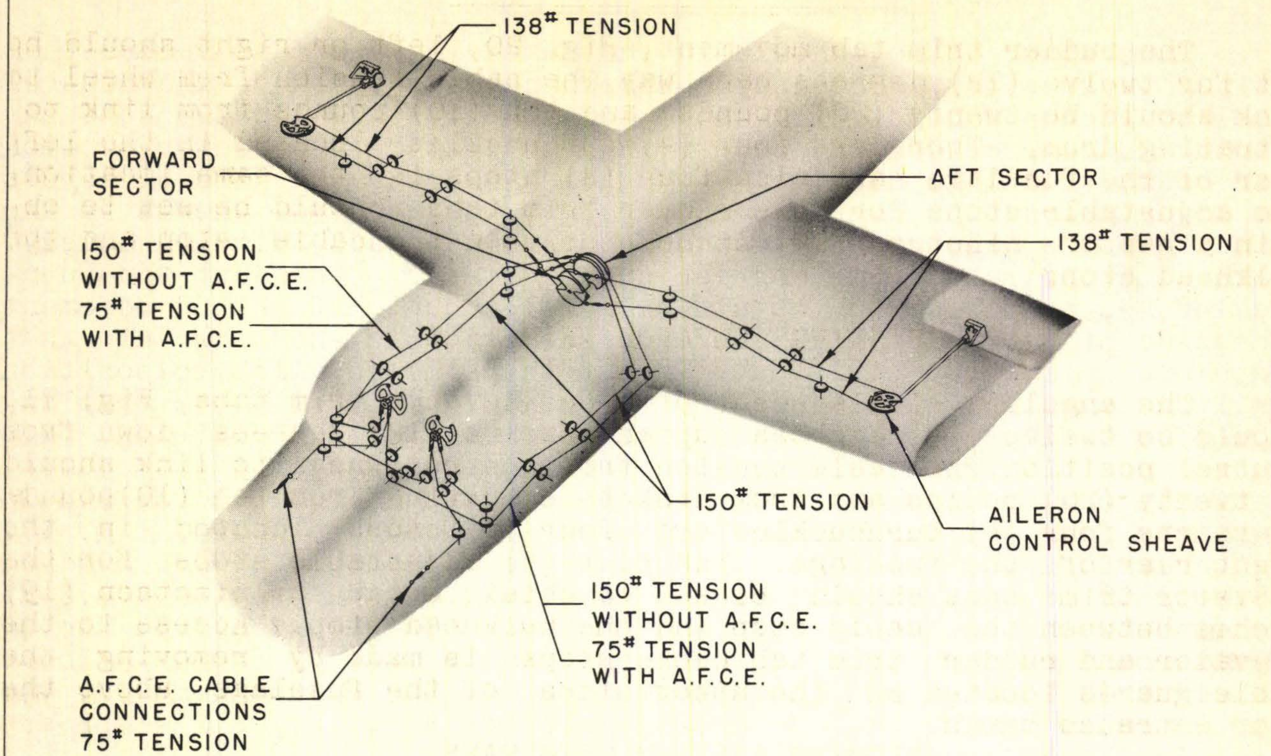


FIG. 17 RIGGING AILERON CONTROL SYSTEM

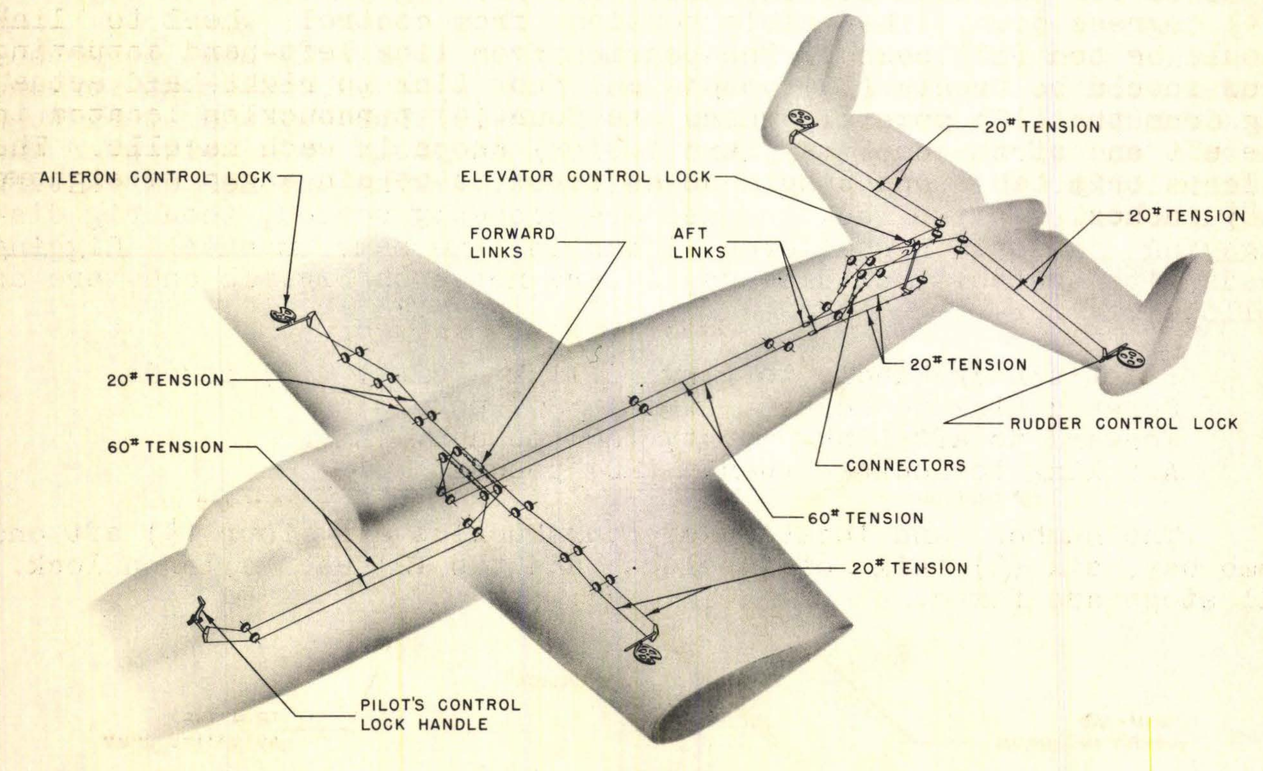


FIG. 18 RIGGING CONTROL LOCK SYSTEM

RIGGING RUDDER TRIM TABS

The rudder trim tab movement, Fig. 20, left or right should be set for twelve (12) degrees each way. The cable tension from wheel to link should be twenty (20) pounds; and ten (10) pounds from link to actuating drum. There are four (4) turnbuckles located in the left rear of the fuselage and also four (4) stops in the same location. The adjustable stops for the rudder trim tabs should be set to obtain a gap of nineteen (19) inches between the cable stop and the bulkhead stop.

RIGGING ELEVATOR TRIM TABS

The angular displacement of the elevator trim tabs, Fig. 21, should be twelve (12) degrees up and twelve (12) degrees down from neutral position. The cable tension from control wheel to link should be twenty (20) pounds and from link to actuating drum ten (10) pounds. There are four (4) turnbuckles and four (4) stops located in the right rear of the fuselage. The four (4) adjustable stops for the elevator trim tabs should be set to obtain a gap of nineteen (19) inches between the cable stop and the bulkhead stop. Access to the elevator and rudder trim tab cable stops is made by removing the cable guards located on the upper sides of the fuselage above the rear entrance hatch.

RIGGING AILERON TRIM TABS

The angular movement of the aileron trim tabs, Fig. 19, should be adjusted for thirteen and one-half (13-1/2) degrees up and fourteen (14) degrees down. The cable tension from control wheel to link should be ten (10) pounds. The tension from link left-hand actuating drum should be twenty (20) pounds and from link to right-hand actuating drum ten (10) pounds. There are four (4) turnbuckles located in the aft end of the bomb bay, and two (2) stops in each nacelle. The aileron trim tab stops should be adjusted to obtain a gap of eighteen (18) inches.

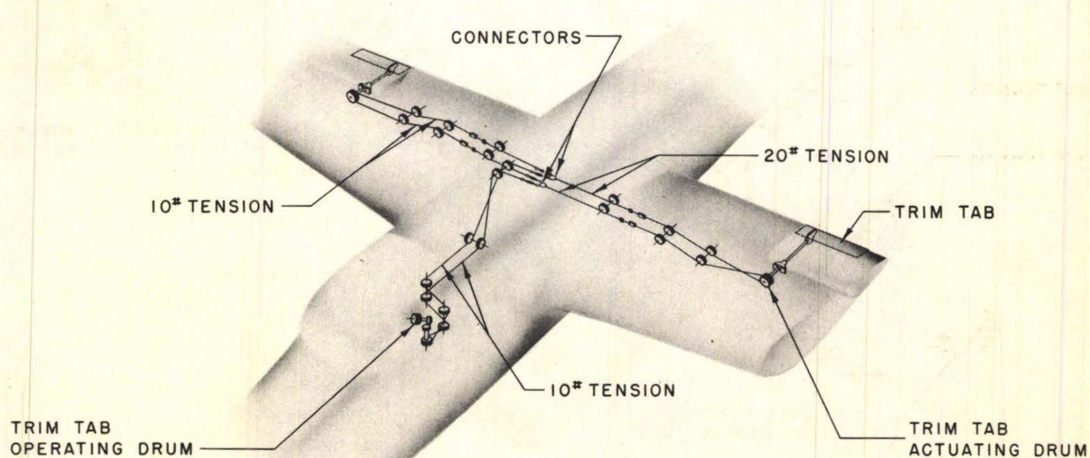


FIG. 19 RIGGING AILERON TRIM TAB SYSTEM

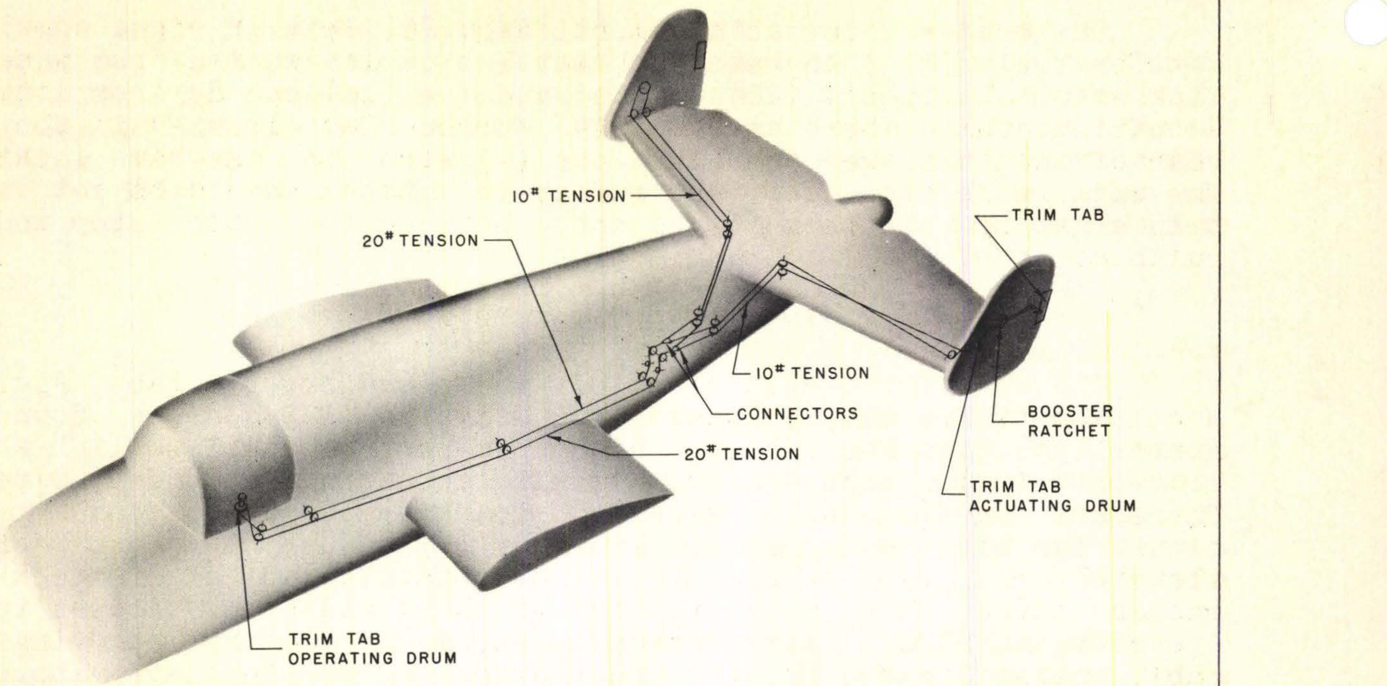


FIG. 20 RIGGING RUDDER TRIM TAB SYSTEM

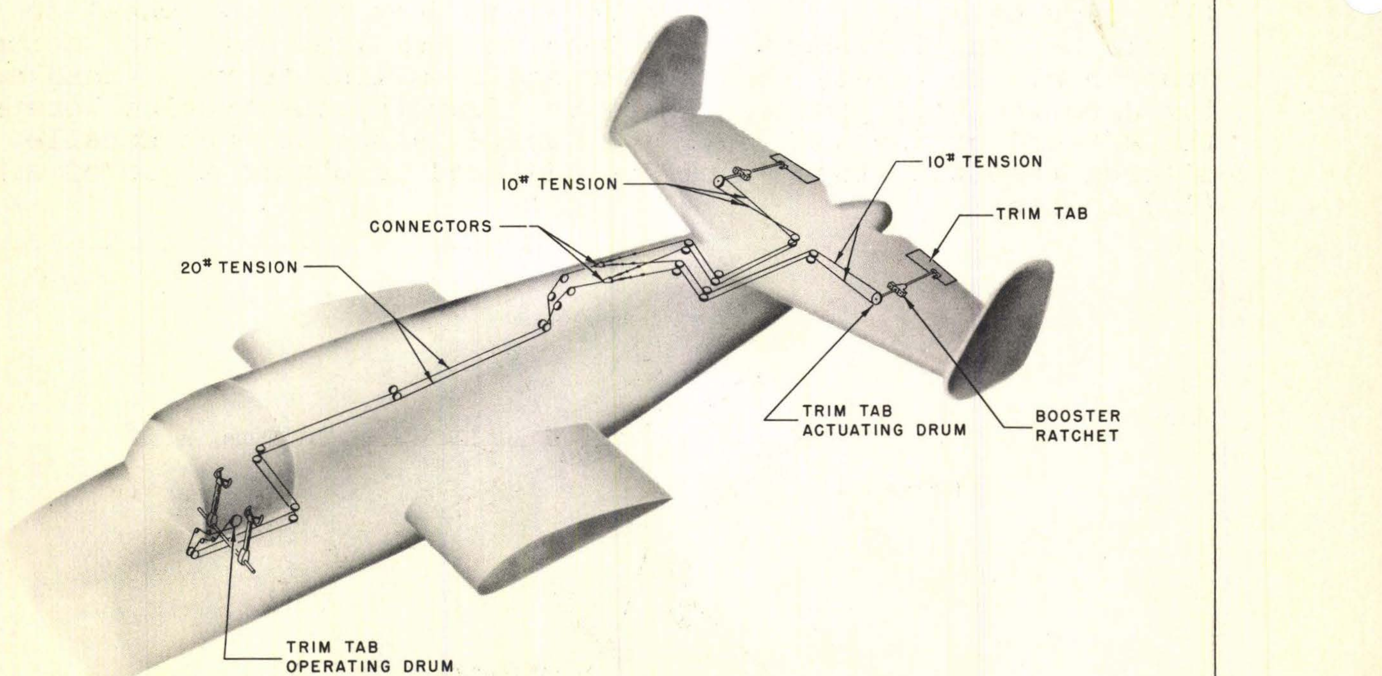


FIG. 21 RIGGING ELEVATOR TRIM TAB SYSTEM

RIGGING TRIM TAB BOOSTER RATCHETS

It is to be noted, in the following adjustment instructions, that the tab booster ratchets will be so adjusted as to entirely eliminate all play. A ratchet booster adjustment for each tab is located at the respective elevator, rudder and aileron hinge lines. Eight provisions are provided. To increase the booster action of the tabs, move the elevator ratchet up, the rudder ratchet inboard and the aileron ratchet down.

RIGGING A.F.C.E. CABLES

A.F.C.E. and Sperry A-3 Pilot:-

Some ships are equipped with A.F.C.E. while others have the Sperry A-3 Automatic pilot. The rudder and aileron servos of both types are connected in the same manner while the elevator servos are connected as shown in Figs. 6, 15 and 16. All the cable tensions connecting into main cable systems on both A.F.C.E. and A-3 Pilot are 75#.

The A.F.C.E. rudder system has two (2) turnbuckles; one (1) right-hand and one (1) left-hand located at outboard rudder pedals. The A.F.C.E. elevator system has two (2) turnbuckles; one (1) right-hand and one (1) left-hand below the outboard rudder pedals. There are no stops on the A.F.C.E. cables.

IDENTIFICATION OF CABLES, CRANKS, HORNS

AILERONS:

CONT. COL. R.H. CABLES..............BLUE
CONT. COL. L.H. CABLES..............RED
L.H. WING SECTOR (FWD.)..............RED
R.H. WING SECTOR (AFT.)..............BLUE
R.H. WING SECTOR (FWD.)..............BLUE
R.H. WING SECTOR (AFT.)..............RED

AILERON TRIM TAB:

COCKPIT DRUM (FWD.)..................BLUE
COCKPIT DRUM (AFT.)..................RED
L.H. WING DRUM (UPPER)...............RED
L.H. WING DRUM (LOWER)...............BLUE
R.H. WING DRUM (UPPER)...............BLUE
R.H. WING DRUM (LOWER)...............RED

ELEVATORS:

COCKPIT HORN (FWD.)..................YELLOW
COCKPIT HORN (AFT.)..................BLACK
ELEVATOR HORN (LOWER)................BLACK
ELEVATOR HORN (UPPER)................YELLOW

ELEVATOR TRIM TAB:

COCKPIT WHEEL (FWD.).................BLACK
COCKPIT WHEEL (AFT.).................YELLOW
L.H. ELEV. DRUM (UPPER)..............BLACK
L.H. ELEV. DRUM (LOWER)..............YELLOW
R.H. ELEV. DRUM (UPPER)..............YELLOW
R.H. ELEV. DRUM (LOWER)..............BLACK

RUDDER:

RIGHT PEDAL..........................GREEN
LEFT PEDAL...........................WHITE
L.H. RUDDER SECTOR (FWD.)............WHITE
L.H. RUDDER SECTOR (AFT.)............GREEN
R.H. RUDDER SECTOR (FWD.)............GREEN
R.H. RUDDER SECTOR (AFT.)............WHITE

RUDDER TRIM TAB:

COCKPIT DRUM (FWD.)..................GREEN
COCKPIT DRUM (AFT.)..................WHITE
RUDDER DRUM (INBOARD)................GREEN
RUDDER DRUM (OUTBOARD)...............WHITE

LOCKS:

COCKPIT HORN (UPPER).................SILVER
COCKPIT HORN (LOWER).................BROWN
L.H. AILE. LOCK HORN (UPPER).........SILVER
L.H. AILE. LOCK HORN (LOWER).........BROWN
R.H. AILE. LOCK HORN (UPPER).........BROWN
R.H. AILE. LOCK HORN (LOWER).........SILVER
ELEVATOR SECTOR (R.H.)...............SILVER
ELEVATOR SECTOR (L.H.)...............BROWN
RUDDER LOCK HORN (UPPER).............SILVER
RUDDER LOCK HORN (LOWER).............BROWN

CABLES, BELLCRANKS, HORNS

AILERONS:
- L. HORN-STICK TORQUE TUBE (& CABLE ENDS).....RED
- R. HORN-STICK TORQUE TUBE (& CABLE ENDS)....BLUE
- FWD. END OF WING BELLCRANKS & CABLE ENDS.....RED
- AFT. END OF WING BELLCRANKS & CABLE ENDS....BLUE

ELEVATORS:
- FWD. SIDE-STICK SOCKET (& CABLE ENDS).....YELLOW
- AFT. SIDE-STICK SOCKET (& CABLE ENDS)......BLACK
- UPPER ELEVATOR HORN (NOSE UP).............YELLOW
- LOWER ELEVATOR HORN (NOSE DOWN)............BLACK

RUDDER:
- L. HORN AT RUDDER (& CABLE ENDS)..........WHITE
- R. HORN AT RUDDER (& CABLE ENDS)...........GREEN

TRIM TAB CABLES:
- AILERON-INBOARD (AT CONTROL DRUM)...........BLUE
- OUTBOARD (AT CONTROL DRUM)............RED
- ELEVATOR-UPPER (NOSE HEAVY)...............YELLOW
- LOWER (TAIL HEAVY)..............BLACK
- RUDDER-UPPER (RIGHT TRIM)..................GREEN
- LOWER (LEFT TRIM)..................WHITE

TAIL WHEEL:
- LEFT HORN (& CABLE END)....................WHITE
- RIGHT HORN (& CABLE END)...................GREEN

LOAD & BAL.

NORTH AMERICAN AVIATION Inc.

Load & Balance LECTURE

B-25 SERIES AIRPLANES

PREPARED BY G. V. Johnson

NOTE

THE INFORMATION CONTAINED IN THIS LECTURE WAS CORRECT AS OF MAY 15, 1942. REFER TO HANDBOOK OF OPERATION AND SERVICE INSTRUCTIONS FOR THE LATEST INFORMATION.

THIS DOCUMENT CONTAINS INFORMATION AFFECTING THE NATIONAL DEFENSE OF THE UNITED STATES WITHIN THE MEANING OF THE ESPIONAGE ACT, 50 U.S.C., 31 AND 32. ITS TRANSMISSION OR THE REVELATION OF ITS CONTENTS IN ANY MANNER TO AN UNAUTHORIZED PERSON IS PROHIBITED BY LAW.

N A A

INGLEWOOD, CALIFORNIA

I N D E X

I L L U S T R A T I O N S

ITEMS	LOCATION	BALLAST OR ITEMS REQUIRED AT ALL TIMES		OTHER ITEMS OF USEFUL* LOAD-USE ANY COMBINATION		LOCATION OF BALLAST
		ITEMS (LBS.)	BALLAST (LBS.)	NORMAL (LBS.)	OVERLOAD (LBS)	
CREW						
PILOT & PARACHUTE	PILOT'S SEAT	200	200			PILOT'S SEAT
CO-PILOT & PARACHUTE	CO-PILOT'S SEAT	200	200			CO-PILOT'S SEAT
BOMBARDIER & PARACHUTE	NAV. OR BOMBARD. SEAT	200	200			NAVIGATOR'S SEAT
RADIO OPERATOR & PARACHUTE	RADIO OPERATOR'S SEAT	200	200			RADIO OPERATOR'S SEAT
GUNNER & PARACHUTE	UPPER TURRET SEAT			200		
FUEL						
358 GAL. (NORMAL)	FRONT WING COMPTS.			2148		
76 GAL. (NORMAL)	REAR WING COMPTS.			456		
*224 GAL. (OVERLOAD)	REAR WING COMPTS.				*1344	
585 GAL. (OVERLOAD)	BOMB BAY DROP. TANK				3510	
OIL						
39.4 GAL. (NORMAL)	WING COMPARTMENT	½ NORMAL OIL		295.5		
2.6 GAL. (PROP. FEATHER)	WING COMPARTMENT SUMP	20				
38 GAL. (OVERLOAD)	WING COMPARTMENT				285	
ARMAMENT						
.30 CAL. FLEX. GUN INSTALLATION	NOSE	74.75	80			BOMBARDIER'S RIDING SEAT
TOP TURRET INSTALLATION						
2-.50 CAL. GUNS	TOP TURRET	128	100			UPPER TURRET AMMUN. BOXES
AMMUNITION (NORMAL-400 RDS.)	TOP TURRET			100	112.5	
BOTTOM TURRET INSTALLATION						
2-.50 CAL. GUNS	BOTTOM TURRET	128	100			BOTTOM TURRET AMMUN. BOXES
AMMUNITION (NORMAL-400 RDS.)	BOTTOM TURRET			100	82.5	
BOMB INSTALLATION (DEMOLITION)						
NORMAL DESIGN LOAD						
* 1-2000 LB. BOMB, M-34	BOMB BAY			2050		
* 1-SHACKLE, D-6	BOMB BAY			9		
* 1-RELEASE, A-2	BOMB BAY			2.7		
* 1-BOMB RACK	BOMB BAY			61		
MISCELLANEOUS EQUIP.						
T-3A PHOTOGRAPHIC EQUIPMENT	AFT OF REAR ENTRANCE			145.5		
ALTERNATE LOAD ITEMS						
2-LIFE PRESERVER CUSHIONS	PILOTS' SEATS				7	
1-LIFE RAFT	RADIO COMPARTMENT				52	
4-MOORING KITS, D-1	BASE OF UPPER TURRET				44	
*1-BOMB BAY FUEL TANK INSTAL.	BOMB BAY				325	
*1-TOW TARGET GEAR, ETC.	BOMB BAY					
DE-ICER BOOTS AND FLUID	WINGS & EMPENNAGE				111	
SIGNAL EQUIPMENT CONSISTS OF:	BASE OF UPPER TURRET				11	
1-SIGNAL CONTAINER, A-1	BASE OF UPPER TURRET					
9-SIGNALS, M-10 OR M-11	BASE OF UPPER TURRET					
1-SIGNAL PISTOL, M-2	BASE OF UPPER TURRET					
1-HOLDER ASSEM.-PISTOL, A-1	BASE OF UPPER TURRET					
WEIGHT EMPTY ITEMS						
A.F.C. EQUIPMENT	BOMBARDIER'S COMPT.	101	100			BOMBARDIER'S RIDING SEAT
UPPER TURRET INSTALLATION	TURRET COMPARTMENT	423	400			TURRET COMPT. FLOOR
LOWER TURRET INSTALLATION	TURRET COMPARTMENT	404	400			TURRET COMPT. FLOOR

NOTES:

1 NORMAL GROSS WEIGHT & HORIZONTAL C.G. (BOMBARDIER IN NAVIGATOR'S SEAT)
- A WEIGHT - 25450 LBS.
- B C.G. (GEAR DOWN) - 26.8% M.A.C.
- C C.G. (GEAR UP) - 28.9% M.A.C.

2 HORIZONTAL C.G. ALLOWABLE RANGE
- A MOST FORWARD C.G. - 20.0% M.A.C. (GEAR DOWN)
- B MOST REARWARD C.G. - 32.0% M.A.C. (GEAR UP)

3 MAXIMUM OVERLOAD GROSS WEIGHT FROM TABLE ABOVE EQUAL TO 29213 LBS. CONSISTS OF A CREW OF FIVE, 1243 GAL. FUEL, 80 GAL. OIL, ONE .30 CAL. FLEX. NOSE GUN INSTALLATION, FOUR .50 CAL. TURRET GUN INSTALLATIONS, MAXIMUM .50 CAL. AMMUNITION, PHOTOGRAPHIC EQUIPMENT, TWO LIAISON SPARE COILS, TWO LIFE PRESERVER CUSHIONS, ONE LIFE RAFT, FOUR MOORING KITS, SIGNAL EQUIPMENT, DE-ICER BOOTS AND FLUID. FOR SPECIAL FERRYING LOADS EXCEEDING 29213 LBS, SEE SPECIAL FERRYING INSTRUCTIONS, PROVIDED WITH EACH AIRPLANE.

*4 BOMB BAY FUEL TANK INSTALLATION AND OVERLOAD FUEL IN BOMB BAY TANK OR TOW TARGET GEAR CAN ONLY BE INSTALLED WHEN BOMBS ARE NOT CARRIED. ALTERNATE NORMAL AND OVERLOAD BOMB LOADS AS SHOWN ON BOMB CHARTS IN BOMB BAY MAY BE CARRIED IN PLACE OF NORMAL DESIGN LOAD LISTED ABOVE. (2000 LB. BOMB INSTALLATION)

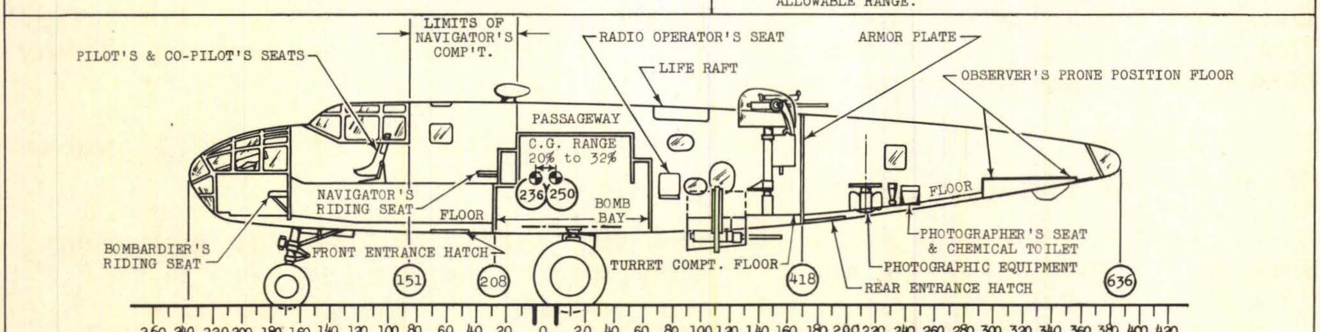
5 A SUPPLIES, MISCELLANEOUS EQUIPMENT, ETC., MAY BE CARRIED IN THE BOMB BAY ON A REMOVABLE PLATFORM, IN PLACE OF BOMBS OR OVERLOAD FUEL, WITHOUT POSSIBILITY OF EXCEEDING C.G. LIMITS. DO NOT EXCEED MAXIMUM USEFUL LOAD.

5 B IF EITHER THE A.F.C. EQUIPMENT OR NOSE FLEX. GUN INSTALLATION OR BOTH HAS BEEN REMOVED AND NOT BALLASTED FOR, AN EQUIVALENT AMOUNT OF SUPPLIES OR MISCELLANEOUS EQUIPMENT MAY BE PLACED IN THE BOMBARDIER'S COMPARTMENT INSTEAD OF BALLAST.

6 WARNING

A MISCELLANEOUS EQUIPMENT, SUPPLIES, ETC. IN PLACE OF OR EXCEEDING NORMAL EQUIPMENT LISTED IN THE CHART ABOVE SHOULD NOT BE CARRIED ON THE OBSERVER'S FLOOR OR ANY OTHER LOCATION AFT OF THE CHEMICAL TOILET, DUE TO LACK OF NECESSARY TIE-DOWN FACILITIES, AND TO KEEP THE C.G. WITHIN THE ALLOWABLE RANGE.

B THE BOMBARDIER'S SEAT SHOULD NOT BE OCCUPIED BY PERSONNEL WHEN THE AIRPLANE IS LOADED TO MOST FORWARD C.G. (20.0% M.A.C.) AS THE MOVEMENT OF PERSONNEL FROM ANY OF THEIR NORMAL FLIGHT POSITIONS TO THE BOMBARDIER'S SEAT WOULD SHIFT THE C.G. FORWARD OF THE ALLOWABLE RANGE. ALSO, THE OBSERVER'S STATION IN THE TAIL END, AND/OR THE PHOTOGRAPHIC SEAT SHOULD NOT BE OCCUPIED BY PERSONNEL WHEN THE AIRPLANE IS LOADED TO THE MOST REARWARD C.G. (MAXIMUM GROSS WEIGHT) AS THE MOVEMENT OF PERSONNEL FROM ANY OF THEIR NORMAL FLIGHT POSITIONS WOULD SHIFT THE C.G. AFT OF THE ALLOWABLE RANGE.



AIRPLANE LOADING CHART (B-25D)

RESTRICTED

INTRODUCTION

With the advent of the nose wheel type landing gear, as on the B-25, it has become possible to place equipment, personnel, supplies, or ballast at any place in the fuselage from the nose to the extreme tail. Thus, the loading and balancing of the airplane has become critical since it is possible to exceed the allowable limits of weight and C. G. Therefore, we have been requested by the Engineering Section at Wright Field to provide a simple loading chart to be placed in each airplane of the B-25 series. This chart is located at the front entrance hatch on the under side of the section of the floor over the hatch. (Reference N.A.A. drawing No. 62-53276 and 62-310385). A copy of the B-25C chart, reduced in size to eight and one-half (8-1/2) inches by eleven (11) inches, is included as an addendum to this lecture. Also included as addendum to this lecture are reduced size charts for the B-25, B-25A and B-25B airplanes with an explanation of same.

EXPLANATION OF CHART B-25C

The chart consists of a table of Useful Load Items, Notes and an inboard profile cut-away of the fuselage showing the location of seats, compartments, gun stations, etc. The basis of this loading chart is the Weight Empty of the airplane as completed and ready for acceptance flight. However, since there is a possibility of certain weight empty items being left out of the airplane, they have been added at the bottom of the table of useful load items. These items are the A.F.C. Equipment or A-3 pilot and the upper and lower turrets. It is essential that these items be in the airplane at all times or ballasted for as indicated in the table.

There are five main columns in the table. The first column lists the items of useful load, such as crew, fuel, oil, armament, miscellaneous equipment and alternate load items. The second column lists the location of each item. The third column lists the weight of all items or equivalent ballast which must be in the airplane for any flight condition from most forward to most rearward allowable C. G., see note No. 2. The fourth column lists the weight of all normal and overload items, any combination of which may be used except as stated in note No. 4, that is, if the bomb bay droppable tank or tow target gear is installed no bombs can be carried. Also, that alternate normal and overload bomb loads as shown on charts in the bomb bay, may be carried in place of those listed in the table. The fifth column lists the location of the ballast necessary if any items in column three are missing.

Note No. 3 lists the items that make up the maximum allowable gross weight.

If the airplane is to be used to carry supplies or equipment, Note No. 5 states where and how much may be carried.

Note No. 6A is a warning as to where supplies and equipment should not be carried under any loading conditions. There is one

exception, and that is that straps are provided to secure the service ladder to the side frames aft of the toilet. Note No. 6B is a warning as to where personnel should not ride when the airplane is loaded to the most forward or rearward allowable C.G. conditions. As on the B-25B, the re-arrangement of the aft part of the airplane to include two turrets and no tail gun has moved the C. G. aft to such a position that it is essential that the table and notes be followed rigidly.

At the bottom of each chart is the inboard profile cut-away of the fuselage. The numbers in the circles represent stations of the airplane or distance from the nose of the airplane which is station 0. In the bomb bay section it will be noted that the forward and rearward C. G. allowable limits, twenty (20) to thirty-two (32) percent, are located by station number, namely station 236 and 250. The ground line is graduated in increments of ten (10) inches to aid in distributing extra equipment or personnel in the airplane so as not to exceed the allowable C. G. range. The forward C. G. limit, Station 236, is used as the 0 point for graduating the ground line forward and the rearward C.G. limit, Station 250, is the 0 point for graduating the ground line aft. For example, if the airplane was lightly loaded so that the C. G. approached the forward limit, Station 236, and one hundred (100) pounds of baggage or equipment were added and placed in the tunnel under the pilot, say at a distance of one hundred and twenty (120) inches forward of Station 236, an equivalent amount of ballast (or half of the baggage or equipment) should be placed a distance of one hundred and twenty (120) inches aft, or as indicated on the diagram, approximately at the radio seat.

In comparing the B-25C chart with the B-25B chart the following changes will be noted: The bomb load has been changed from four (4) six hundred (600) pound bombs to one (1) two thousand (2000) pound bomb in normal load; the two (2) six hundred (600) pound bombs (overload) have been eliminated; two items, namely, pyrotechnics and bomb bay tank installation have been removed from miscellaneous equipment and added to alternate load; three new items have been added to alternate load, namely, mooring kits, tow target installation and de-icer boots and fluid; the lower turret guns or ballast have been added to the "must" items in the third main column; and the notes have been partially re-arranged and re-worded.

In conclusion, the chart covers all conditions for which the airplane was designed, from light weight condition to maximum overload conditions, and should be followed rigidly in order to prevent operating personnel from overloading or placing items of freight, supplies, or personnel in such positions in the airplane that the C. G. or flying qualities are affected.

ITEMS	LOCATION	BALLAST OR ITEMS REQUIRED AT ALL TIMES: ITEMS (LBS.)	BALLAST (LBS.)	OTHER ITEMS OF USEFUL* LOAD-USE ANY COMBINATION: NORMAL (LBS.)	OVERLOAD (LBS.)	LOCATION OF BALLAST
CREW						
PILOT & PARACHUTE	PILOT'S SEAT	200	200			PILOT'S SEAT
CO-PILOT & PARACHUTE	CO-PILOT'S SEAT	200	200			CO-PILOT'S SEAT
BOMBARDIER & PARACHUTE	NAV. OR BOMBARD. SEAT	200	200			NAVIGATOR'S SEAT
RADIO OPERATOR & PARACHUTE	RADIO OPERATOR'S SEAT	200	200			RADIO OPERATOR'S SEAT
GUNNER & PARACHUTE	UPPER TURRET SEAT			200		
FUEL						
358 GAL. (NORMAL)	FRONT WING COMPTS.			2148		
76 GAL. (NORMAL)	REAR WING COMPTS.			456		
*224 GAL. (OVERLOAD)	REAR WING COMPTS.				*1344	
*585 GAL. (OVERLOAD)	BOMB BAY DROP. TANK				*3510	
OIL						
39.4 GAL. (NORMAL)	WING COMPARTMENT	½ NORMAL OIL		295.5		
2.6 GAL. (PROP. FEATHER)	WING COMPARTMENT SUMP	20				
38 GAL. (OVERLOAD)	WING COMPARTMENT				285	
ARMAMENT						
.30 CAL. FLEX. GUN INSTALLATION	NOSE	74.75	80			BOMBARDIER'S RIDING SEAT
TOP TURRET INSTALLATION						
2-.50 CAL. GUNS	TOP TURRET	128	100			UPPER TURRET AMMUN. BOXES
AMMUNITION (NORMAL-400 RDS.)	TOP TURRET			100	112.5	
BOTTOM TURRET INSTALLATION						
2-.50 CAL. GUNS	BOTTOM TURRET	128	100			BOTTOM TURRET AMMUN. BOXES
AMMUNITION (NORMAL-400 RDS.)	BOTTOM TURRET			100	82.5	
BOMB INSTALLATION (DEMOLITION)						
NORMAL DESIGN LOAD						
* 1-2000 LB. BOMB, M-34	BOMB BAY			2050		
* 1-SHACKLE, D-6	BOMB BAY			9		
* 1-RELEASE, A-2	BOMB BAY			2.7		
* 1-BOMB RACK	BOMB BAY			61		
MISCELLANEOUS EQUIP.						
T-3A PHOTOGRAPHIC EQUIPMENT	AFT OF REAR ENTRANCE			145.5		
ALTERNATE LOAD ITEMS						
2-LIAISON SPARE COILS	RADIO COMPARTMENT				32	
2-LIFE PRESERVER CUSHIONS	PILOTS' SEATS				7	
1-LIFE RAFT	RADIO COMPARTMENT				52	
4-MOORING KITS, D-1	BASE OF UPPER TURRET				44	
*1-BOMB BAY FUEL TANK INSTAL.	BOMB BAY				325	
*1-TOW TARGET GEAR, ETC.	BOMB BAY					
DE-ICER BOOTS AND FLUID	WINGS & EMPENNAGE				111	
SIGNAL EQUIPMENT CONSISTS OF:	BASE OF UPPER TURRET				11	
1-SIGNAL CONTAINER, A-1	BASE OF UPPER TURRET					
9-SIGNALS, M-10 OR M-11	BASE OF UPPER TURRET					
1-SIGNAL PISTOL, M-2	BASE OF UPPER TURRET					
1-HOLDER ASSEM.-PISTOL, A-1	BASE OF UPPER TURRET					
WEIGHT EMPTY ITEMS						
A.F.C. EQUIPMENT	BOMBARDIER'S COMPT.	101	100			BOMBARDIER'S RIDING SEAT
OR A-3 PILOT	BOMBARD. & PILOT'S COMPT.	63	60			BOMBARDIER'S RIDING SEAT
UPPER TURRET INSTALLATION	TURRET COMPARTMENT	423	400			TURRET COMPT. FLOOR
LOWER TURRET INSTALLATION	TURRET COMPARTMENT	404	400			TURRET COMPT. FLOOR

NOTES:

1 NORMAL GROSS WEIGHT & HORIZONTAL C.G. (BOMBARDIER IN NAVIGATOR'S SEAT)
- A WEIGHT - 25450 LBS.
- B C.G. (GEAR DOWN) - 26.8% M.A.C.
- C C.G. (GEAR UP) - 28.9% M.A.C.

2 HORIZONTAL C.G. ALLOWABLE RANGE
- A MOST FORWARD C.G. - 20.0% M.A.C. (GEAR DOWN)
- B MOST REARWARD C.G. - 32.0% M.A.C. (GEAR UP)

3 MAXIMUM OVERLOAD GROSS WEIGHT FROM TABLE ABOVE EQUAL TO 29245 LBS. CONSISTS OF A CREW OF FIVE, 1243 GAL. FUEL, 80 GAL. OIL, ONE .30 CAL. FLEX. NOSE GUN INSTALLATION, FOUR .50 CAL. TURRET GUN INSTALLATIONS, MAXIMUM .50 CAL. AMMUNITION, PHOTOGRAPHIC EQUIPMENT, TWO LIAISON SPARE COILS, TWO LIFE PRESERVER CUSHIONS, ONE LIFE RAFT, FOUR MOORING KITS, SIGNAL EQUIPMENT, DE-ICER BOOTS AND FLUID. FOR SPECIAL FERRYING LOADS EXCEEDING 29245 LBS, SEE SPECIAL FERRYING INSTRUCTIONS, REPORT NO. NA-5239.

*4 BOMB BAY FUEL TANK INSTALLATION AND OVERLOAD FUEL IN BOMB BAY TANK OR TOW TARGET GEAR CAN ONLY BE INSTALLED WHEN BOMBS ARE NOT CARRIED. ALTERNATE NORMAL AND OVERLOAD BOMB LOADS AS SHOWN ON BOMB CHARTS IN BOMB BAY MAY BE CARRIED IN PLACE OF NORMAL DESIGN LOAD LISTED ABOVE. (2000 LB. BOMB INSTALLATION)

5 A SUPPLIES, MISCELLANEOUS EQUIPMENT, ETC., MAY BE CARRIED IN THE BOMB BAY ON A REMOVABLE PLATFORM, IN PLACE OF BOMBS OR OVERLOAD FUEL, WITHOUT POSSIBILITY OF EXCEEDING C.G. LIMITS. DO NOT EXCEED MAXIMUM USEFUL LOAD.

5 B IF EITHER THE A.F.C. EQUIPMENT (OR A-3 PILOT) OR NOSE FLEX. GUN INSTALLATION OR BOTH HAS BEEN REMOVED AND NOT BALLASTED FOR, AN EQUIVALENT AMOUNT OF SUPPLIES OR MISCELLANEOUS EQUIPMENT MAY BE PLACED IN THE BOMBARDIER'S COMPARTMENT INSTEAD OF BALLAST.

6 **WARNING**
- A MISCELLANEOUS EQUIPMENT, SUPPLIES, ETC. IN PLACE OF OR EXCEEDING NORMAL EQUIPMENT LISTED IN THE CHART ABOVE SHOULD NOT BE CARRIED ON THE OBSERVER'S FLOOR OR ANY OTHER LOCATION AFT OF THE CHEMICAL TOILET, DUE TO LACK OF NECESSARY TIE-DOWN FACILITIES, AND TO KEEP THE C.G. WITHIN THE ALLOWABLE RANGE.
- B THE BOMBARDIER'S SEAT SHOULD NOT BE OCCUPIED BY PERSONNEL WHEN THE AIRPLANE IS LOADED TO MOST FORWARD C.G. (20.0% M.A.C.) AS THE MOVEMENT OF PERSONNEL FROM ANY OF THEIR NORMAL FLIGHT POSITIONS TO THE BOMBARDIER'S SEAT WOULD SHIFT THE C.G. FORWARD OF THE ALLOWABLE RANGE. ALSO, THE OBSERVER'S STATION IN THE TAIL END, AND/OR THE PHOTOGRAPHIC SEAT SHOULD NOT BE OCCUPIED BY PERSONNEL WHEN THE AIRPLANE IS LOADED TO THE MOST REARWARD C.G. (MAXIMUM GROSS WEIGHT) AS THE MOVEMENT OF PERSONNEL FROM ANY OF THEIR NORMAL FLIGHT POSITIONS WOULD SHIFT THE C.G. AFT OF THE ALLOWABLE RANGE.

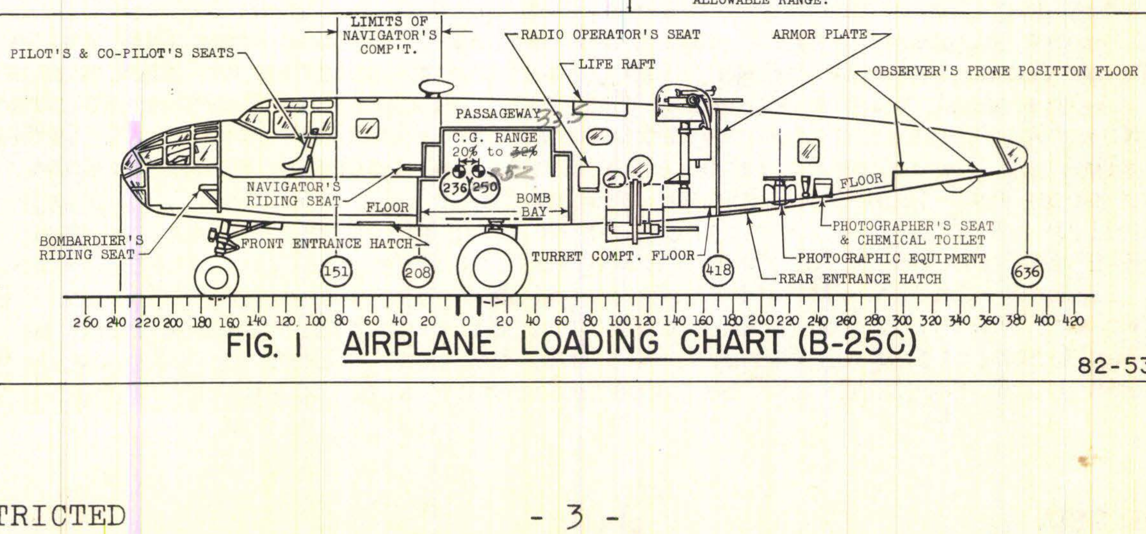


FIG. 1 AIRPLANE LOADING CHART (B-25C)

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ADDENDUM

1. EXPLANATION OF CHARTS, B-25, B-25A AND B-25B

The Airplane Loading Chart consists of a table of Useful Load Items, Notes, and an inboard profile cut-away of the fuselage showing the location of seats, compartments, gun stations, etc. The basis of this loading chart is the Weight Empty of the airplane as completed and ready for acceptance flight. However, since there is a possibility of certain weight empty items being out of the airplane, they have been added at the bottom of the table of useful load items. These items are the A.F.C. Equipment on the B-25, B-25A and B-25B airplanes, and the upper and lower turrets on the B-25B airplanes. It is essential that these items be in the airplane at all times or ballasted for as indicated in the table.

There are five main columns in the table. The first column lists the items of useful load, such as crew, fuel, oil, armament, miscellaneous equipment and alternate load items. The second column lists the location of each item. The third column lists the weight of all items or equivalent ballast which must be in the airplane for any flight condition from most forward to most rearward allowable C. G., see Note No. 2. The fourth column lists the weight of all normal and overload items, any combination of which may be used except as stated in Note No. 3 on the B-25 and B-25A and Note No. 4 on the B-25B, that is, if the bomb bay droppable tank is installed no bombs can be carried. Also, that alternate bomb loads as shown on charts in the bomb bay may be carried in place of those listed in the table. The fifth column lists the location of the ballast necessary if any items of column three are missing.

If the airplane is to be used to carry supplies, equipment or extra personnel, Note No. 4 and No. 5 state where and how many pounds may be carried.

Note No. 6 states what loading conditions should be avoided when the airplane is loaded to the most forward or rearward allowable C. G. conditions. For example, since in the B-25 and B-25A, there are provisions for two (2) extra gunners and one (1) extra .30 caliber flexible gun in the waist gun compartment, it is probable that they may be carried. However, as stated in Note No. 6A, the extra gun and gunners should not be carried when the airplane is loaded to the maximum gross weight obtained from the items listed in the table. The maximum gross weight condition for the B-25 as listed in Note No. 6A, less the bombardier and .30 caliber nose gun installation, loads the airplane to the most rearward C. G. allowable. It can be seen by inspecting the chart that adding the nose gun and bombardier will not offset the two extra gunners and extra gun. On the B-25A, the most forward C. G. allowable can be seen to be the items listed in the third column plus the bombardier, since he is forward of the C.G., and the items in this column must always be in. Again by inspecting the chart it can be seen that by moving any of the personnel forward to the bombardier's seat when the airplane is

NORTH AMERICAN AVIATION Inc.

Structures LECTURE

B-25 SERIES AIRPLANES

PREPARED BY G R Huisman

NOTE

THE INFORMATION CONTAINED IN THIS LECTURE WAS CORRECT AS OF MAY 15, 1942. REFER TO HANDBOOK OF OPERATION AND SERVICE INSTRUCTIONS FOR THE LATEST INFORMATION.

THIS DOCUMENT CONTAINS INFORMATION AFFECTING THE NATIONAL DEFENSE OF THE UNITED STATES WITHIN THE MEANING OF THE ESPIONAGE ACT, 50 U.S.C., 31 AND 32. ITS TRANSMISSION OR THE REVELATION OF ITS CONTENTS IN ANY MANNER TO AN UNAUTHORIZED PERSON IS PROHIBITED BY LAW.

N A A

INGLEWOOD, CALIFORNIA

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ILLUSTRATIONS

STRUCTURE OF THE B-25 AIRPLANE
PART I

The modern airplane as we shall speak of it, is considered to be of the "all metal" type. By this is inferred the use of shell-type construction instead of the heretofore conventional "stick, wire and tube type". The modern airplane is engineered so that all component parts must work in unison. To do this the structure distributes the loads through ribs and spars and makes use of the outer covering to assist in carrying the loads. The latter may be regarded as the distinguishing feature between shell-type construction and the ordinary truss-type used for so many years. In order to design high performance airplanes, the all metal shell-type of airplane is necessary for the following reasons:

1. Greater aerodynamic cleanness or surface smoothness is realized.

2. Wing contours are held to proper dimensions more accurately.

3. Greater structural rigidity is embodied in each assembly.

4. Higher vibrational frequencies are obtained.

5. Critical flutter speeds are increased.

6. Increased life of the airplane.

7. Ease of maintenance.

By the term high performance airplanes, is meant aircraft possessing higher speeds than those of ten years ago obtained by greater aerodynamic efficiency through the use of better wing sections, fuselage shapes, tail surfaces and retractable landing gears. Coincident with this is the increased wing and power loadings. In 1929, an authority on aerodynamics predicted that wing loadings of twenty-five (25) pounds per square foot would be considered a maximum. Today, airplanes are being designed that have wing loadings of fifty (50) pounds per square foot and already designs are projected to include sixty (60) pounds per square foot -- still there is no end in sight. Airplanes are designed to withstand definite maneuver load factors or "g's" as these factors are often referred to. Maneuver load factors are those willfully applied to the airplane through operation of the controls and vary with the type of airplane -- the more maneuverable the airplane, the higher the load factor. Another loading criteria is the matter of atmospheric gusts. These may occur on any airplane and the faster the speed, the more severe their effects. The severity of the gusts is the same for all airplanes and for heavy airplanes such as transports and bombers, flying at high speed may even exceed the maneuver load factors. It is the specified maneuver and gust load factors that design the basic structure of the airplane.

Another item of importance is the effect of air pressures on various parts of the airplane not associated with the support of the

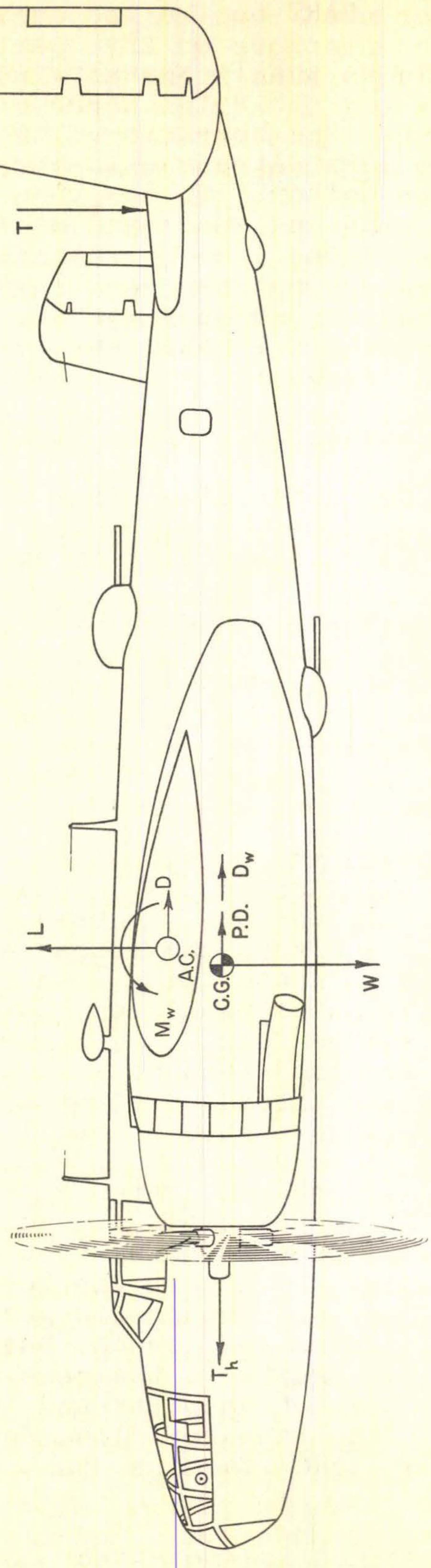


FIG. I FORCE DIAGRAM (FLIGHT CONDITION)

principal air loads. Airplanes whose top speed is less than two hundred (200) miles per hour need not be too carefully investigated for localized increases in pressure on any part of the wetted or exposed surface. This includes such items as windshields, fairings, fillets, etc. For airplanes having a high speed of two hundred (200) miles per hour, the practical consideration of a fairing that will resist wear and tear during maintenance has proven sufficient. The actual loads at two hundred (200) miles per hour on such fairings are not unduly high. The same can be said of the windshield and cockpit enclosure. However, turning to the modern airplane permitting operations in the neighborhood of four hundred (400) miles per hour, the importance of these items assumes new and astounding aspects. The same pieces of fairing, cowlings, windshields, enclosures, etc. would be forced to carry four times the load at four hundred (400) miles per hour as the airplane flying two hundred (200) miles per hour. This is true since these loads increase with the square of the velocity.

Thus it is that such apparently unimportant parts on the modern airplane must actually now be designed with a fair consideration of the loads acting. It is not at all uncommon that a cowling surrounding an engine may be subjected to loads as high as four hundred (400) to five hundred (500) pounds per square foot. Peak loads on the uppermost curve of the windshield for example, may reach the astounding figure of twelve hundred (1200) pounds per square foot. This fact being known, the problem of designing cowlings, fairings, windshields, etc., assumes an altogether different aspect and one which must be considered throughout all phases of manufacture.

In order to have a better understanding of the work that each component part of the airplane must perform, a brief description of the loading conditions may not be amiss. Taking as our first example a typical flight condition, the principal forces acting on the airplane may be demonstrated by the arrows in Figure 1. L represents the wing lift. D is the drag of the wing and strangely enough, for the most part acts forward. The curved line M_W represents the pitching moment of the wing about its aerodynamic center. This curved line represents not a force but an effort to twist the wing away from its attachment to the fuselage. The center on the fuselage marked C.G. represents the center of gravity of the entire airplane and through it pass the inertia forces. W represents the weight of the airplane and D_W the drag inertia forces.

The airplane parasite drag is considered to act through the C. G. for all practical purposes. The vector T_h represents the thrust of the engine-propeller combination. The T represents the load on the horizontal tail surfaces required to balance all other forces about the center of gravity thereby maintaining flight in a proper direction. These are the basic forces acting on the airplane at all times while in flight and represent the resultant of various loadings distributed over the airplane. Thus, for example, the vector L actually represents distributed forces acting over the entire wing area. In a landing condition, the principal forces are as shown in Figure 2. Here the wing forces are replaced by loads on

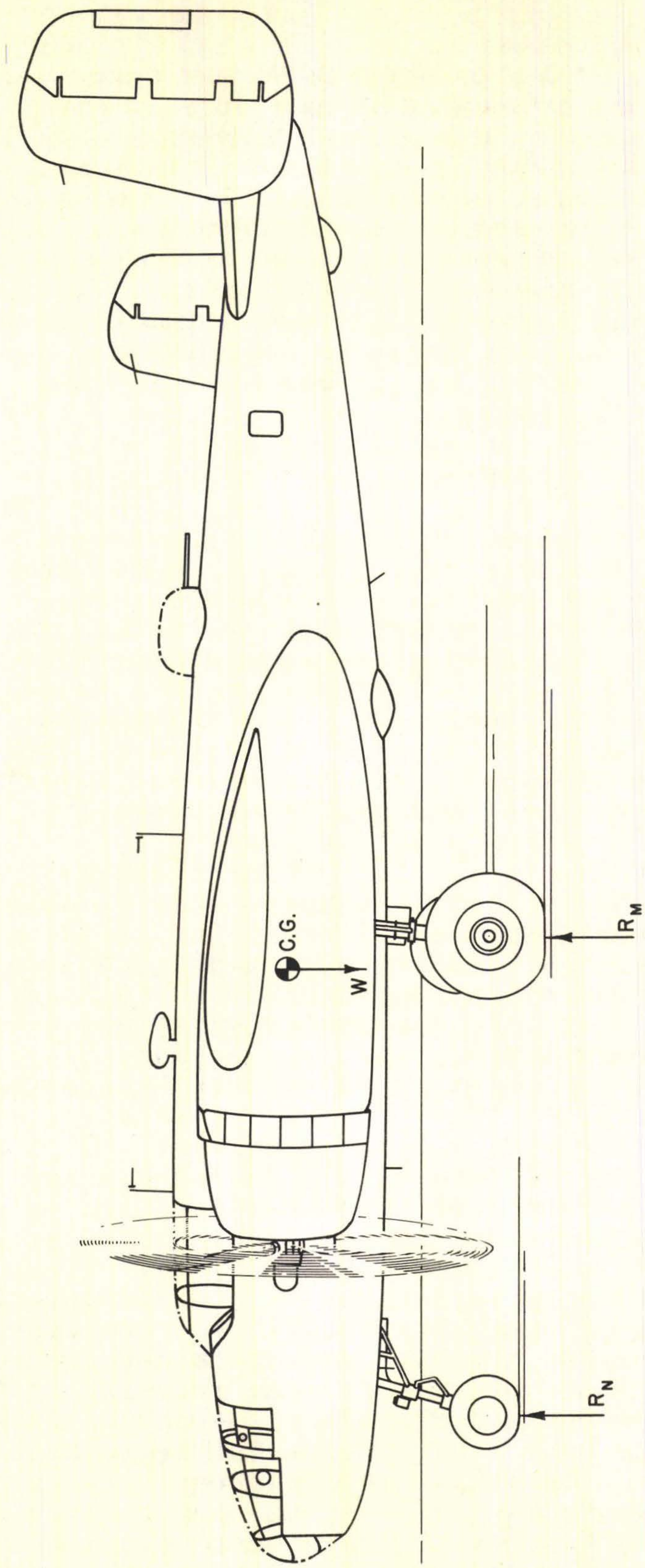


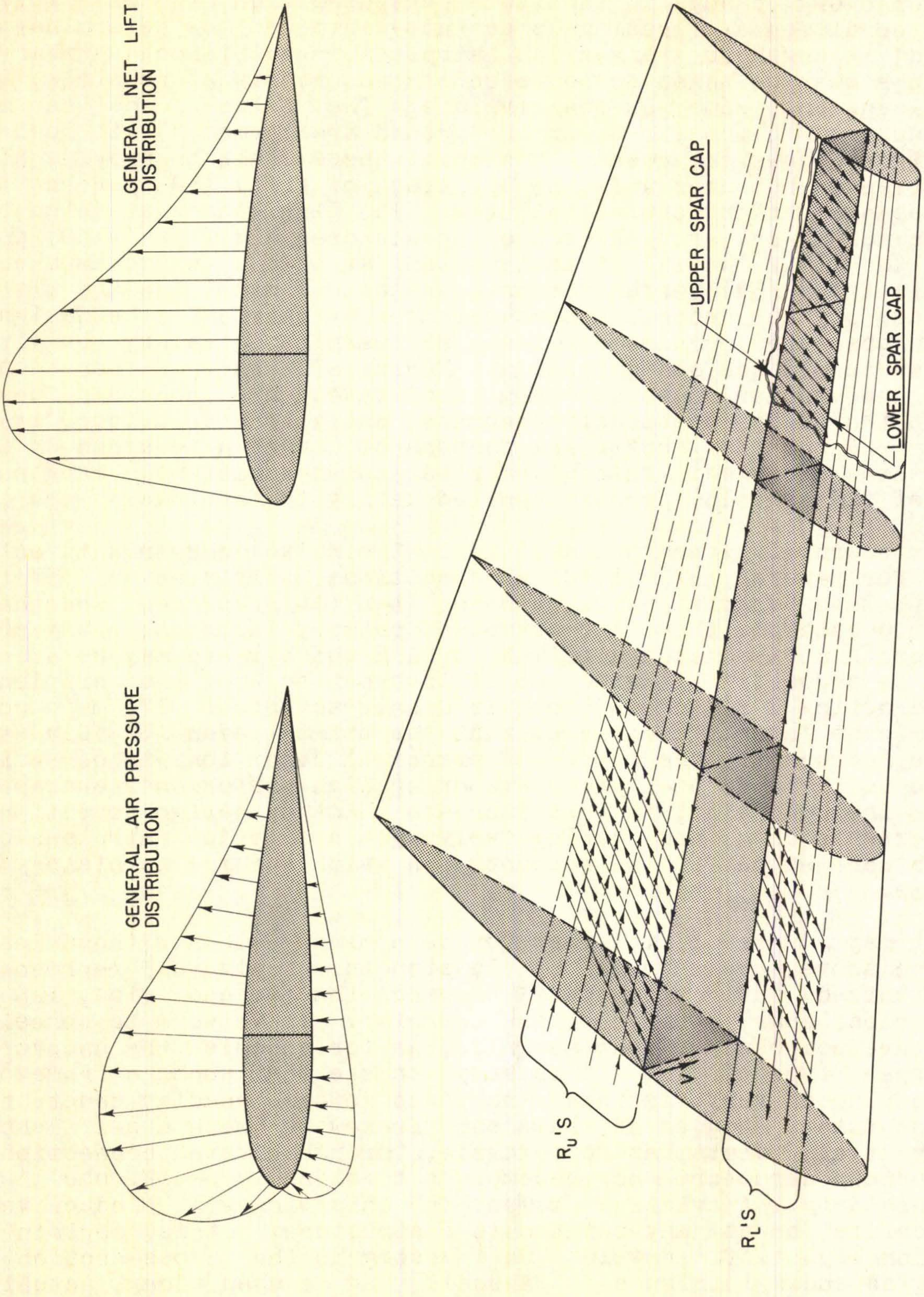
FIG. 2 FORCE DIAGRAM (LANDING CONDITION)

the landing gear and reacted by inertia forces distributed over the entire airplane.

For every change in magnitude and direction of these forces another condition of loading is set up. In order to determine the required strength for any given airplane, a sufficient number of conditions must be taken to represent as accurately as possible, the actual loads that come on the airplane. The actual loads that may be encountered in the air or on the ground are termed "limit loads". The designer, however, does not stop at these loads to provide adequate strength but uses a factor of safety of fifty (50) percent to guarantee against structural failures. The final loads to which the designer must work are, therefore, one hundred and fifty (150) percent of the limit loads. It is important at this point to emphasize that this fifty (50) percent margin between limit loads and ultimate loads may not under any circumstances be waived by the designer. It is an absolute requirement that all margins of safety be given with respect to the design loads. During all salvage operations, this is the manner in which margins of safety are quoted. Due to the fact that many parts defy accurate analytical solutions, it is necessary to provide additional factors to cover unforeseen or indeterminate stresses. This gives rise to an additional margin of safety of fifteen (15) percent applied mainly to fittings.

A modern airplane such as the B-25 airplane requires investigating forty-seven (47) loading conditions, thirty-seven (37) of which are major conditions. The other ten (10) represent secondary or minor conditions that may not be of primary importance. By primary importance is meant a failure during which there may be a loss of life or property. It will be of interest to know that airplanes designed during 1929 and 1930 required only seventeen (17) main conditions to be investigated as against the thirty-seven (37) used today. The increase in the number of principal conditions is of course a change to the modern airplane embodying high performance characteristics. Included also, in this increase in major design conditions, is the experience gained during twelve years of major airplane operations carried out in this country on which a complete history is available.

It may now be of interest to determine just how these loads explained above, are carried by the structure. Figure 3 represents a skeletonized outer wing panel showing the two end ribs, intermediate ribs, spar, stringers and covering. If we were to conceive a structure composed of spar and ribs, as for example the uncovered wooden spar type of wing, it is easy to see that such a framework would be indeed very flexible and would deform readily under the slightest twist. Now cover this same framework with a stiff sheet securely at all joints, as for example, through riveted connections. This revised structure now becomes a torsionally stiff shell of great rigidity. A twisting moment on this wing will induce very little deflection at any point on the structure. It is certain to be torsionally stiff. Now let us investigate the cross-section of the wing as shown in Figure 3. A shell wing as used today, actually represents a cantilever beam which means self-supporting.



SINGLE SPAR WING CONSTRUCTION

FIG. 3

In Figures 4 to 6, are illustrated several simple cases of cantilever beams. Figure 4 illustrates the wide flange H beam. For a given applied load as V the resisting forces at the wall or attachment would be as shown. Likewise for Figures 5 to 6 a modern airplane wing without external bracing is exactly of this type. Instead of a wall to support the beam, each half of the wing supports the other half at the place of symmetry of the airplane. The fuselage supplies the vertical load reaction.

It is evident that the shell must support this load in bending and looking at the end view of the wing shown in Figure 8, we see the envelope of skin, the supporting ribs, spar web and stringers. This wing could be produced by lumping all of the flange material as shown in the shaded area in the figure. This then, would look very much like the ordinary type of structural steel beam found in bridge and building construction. This type of construction, if used in an airplane wing, would cause excessive deflection and wrinkling of the skin which would be objectionable. The spar would continue to deflect under very high loads. The wing skin on the other hand would be subjected to the same deformations as the spar which in turn would cause a great deal of wrinkling throughout the skin surface. This type of construction would not be practical in most wings (on some airplanes it is used). Therefore, the concentrated flange material shown in the shaded area of Figure 8, is replaced by the stringers across the wing surface. The flange material is spread out, so to speak. For bending one can replace the shell wing, for all practical purposes, with a spar web and a long thin flange. The beam then would look as shown in Figure 9. Thus it is seen that almost every particle of material in the upper and lower surface of the wing actually contributes to bending strength.

The air load distribution over any rib is as shown in Figure 3. The rib gets its load from the adjacent skin and stringers and then transmits it to the spar web. The spar web carries this vertical load or shear along its entire length to be reacted at the center section or fuselage as the case may be. This shear is then passed along diagonal "fibers" in the web which changes its direction. This change in direction causes a running load to exist along the attachment of the web to the upper and lower skin surfaces. It is this running load that gets out away from the spar web attachment to deposit part of it along each stringer until all stringers are loaded. In this way, every available stringer contributes its share to the general bending strength of the shell. A transfer of shear along these diagonal fibers is analogous to the framed structure illustrated in Figure 7. When load V is applied at Point 0 on the frame, it passes upward through the outer vertical member and is then transferred to the next lower panel point inboard of where it is applied along the diagonal member marked (a). The load then transfers up through the second vertical member to the diagonal member (b). It is easy to see that when members (a) and (b) are in tension, they pull directly on the chord members A and B. This places compression in the upper member A and tension in the lower member B. The reacting forces for such a truss are marked R_U, R_L, and R_V. This analogy then shows that the spar web is in effect, a large number of diagonal

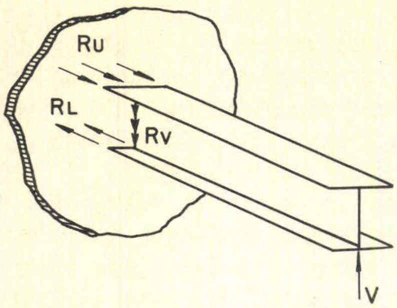


FIG. 4 WIDE FLANGE "I" BEAM

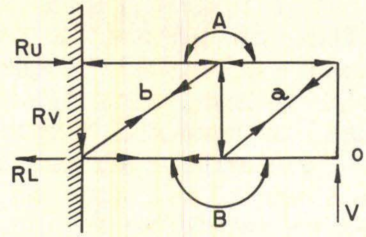


FIG. 7 TRUSS

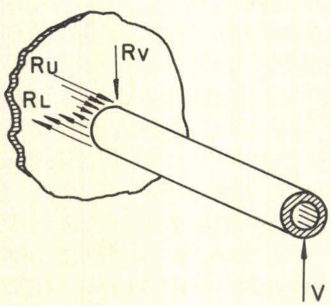


FIG. 5 TUBULAR BEAM

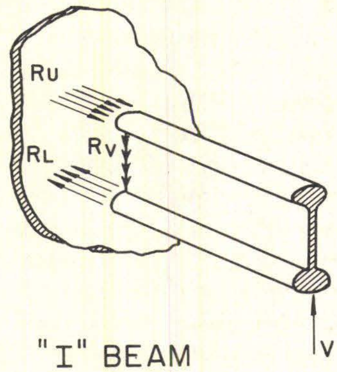


FIG. 6 "I" BEAM

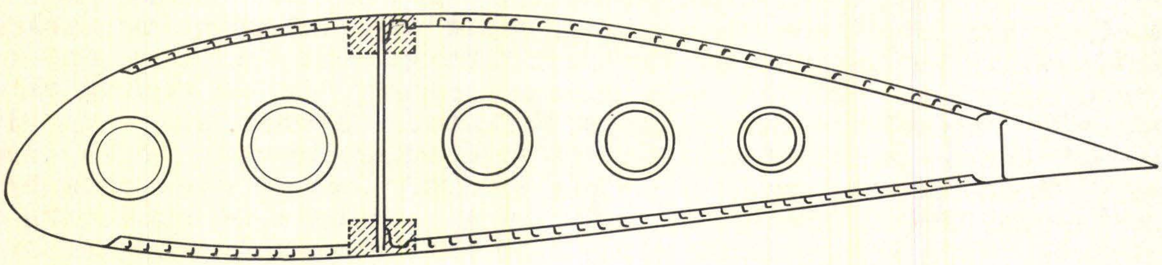


FIG. 8 END VIEW OF WING STRUCTURE

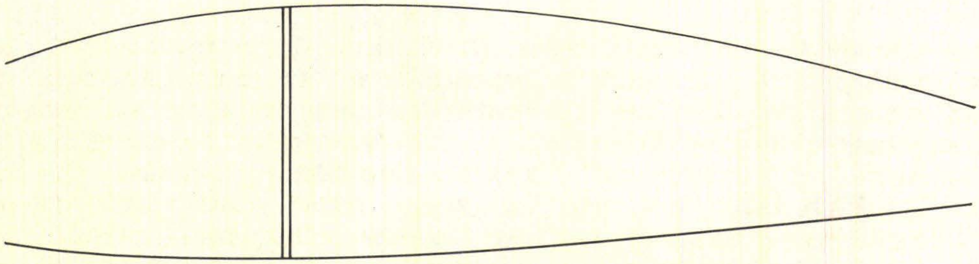


FIG. 9 THEORETICAL END VIEW OF WING STRUCTURE

members placed so close together that they form a single continuous member.

With the above in mind, we return once more to Figure 3. The importance of each element, be it skin, stringer, rib, or spar of the shell wing, contributes its share in composing the general structure to resist forces such as in the case of the wing. If we were to group the reactive forces R_U and R_L in Figure 3 and distribute them along the upper and lower contour of the wing as shown, we could understand the condition of stress that exists at the bolting angles connecting the outer panel to the center section. The function of this bolting angle is simply to transfer the accumulated R_U's and R_L's to adjacent structure where they can be carried through to the centerline of the airplane and there balanced by equal but opposite forces coming from the other half of the wing. No further details will be gone into concerning the design of this shell wing, but it is believed that the above will suffice to illustrate the basic idea. Figure 3 has illustrated how the forces R_U and R_L and V are transmitted into the center section of the wing. In the center section instead of having a single spar as in the outer panel, the shear coming from the outer panel spar must divide and detour along the plate rib at the end of the center section to the front and rear spars where it is transferred to the fuselage attaching fittings. During this transfer of load the diagonal fibers again come into play and proceed to load up the upper and lower surface through two paths instead of one as in the outer panel.

Having this illustration before us of the manner in which these running loads are transferred from web to skin, to stringers, one naturally is brought to the realization that whenever any one of these elements is cut and made discontinuous, the adjoining material is thereby forced to carry an added load. Around any hole in the skin, stresses must detour and in so doing, crowd up in certain areas. Thus, local conditions may result in an over stress that could equal the ultimate stress far in advance of the remaining structure. For an airplane structure to function properly, no such local failures can be permitted. Thus it is that around practically every cut-out, one finds gussets with flanged edges secured to the skin, stringers and adjoining frames through closer spaced rivets. All these items are necessary in order to prevent the local condition of over-stress as mentioned above.

The above merely portrays the basic conception of loading and stress distribution through a structure as complicated as a shell wing. It should be obvious in constructing a wing of this sort that great importance should be placed on the joints carrying the higher running loads. In order of importance these joints in the case of the wing illustrated, are as follows: The lower bolting angle connection, the upper bolting angle, the running shear load between the spar web and the upper and lower surface, the connection of the spar web at the plate rib, (where the entire vertical shear is reacted) the fore and aft skin seams, the longitudinal skin seams adjacent to the spar attachment and lastly, those seams farthest removed from any spar.

The wing center section of the B-25C airplane has removable gas tank doors which form a very important link in the wing structure. The forward door extends from the front spar to the gas web and the rear door extends from the gas web to the rear spar. Both doors are bounded on the inboard end by the fuselage and on the outboard end by the nacelle. These doors are held in place with a series of one fourth (1/4) inch bolts. It is important that these bolts are properly installed and that the bolt holes meet requirements because of the following:

1. The strength of the structure depends upon this connection.

2. Excessive wing deflections will result from loose fitting bolts.

3. The life of the parts is impaired by loose fitting bolts.

The fixed tail surfaces have considerable in common with the shell wing. The horizontal stabilizer, Fig.10,consists mainly of two spars and a stiffened skin cover. It is cantilevered from the aft portion of the fuselage and is attached to reinforced fuselage frames. All the vertical forces are carried in the two spars.Twisting action or torque is resisted in the complete box bounded by the two spars and the upper and lower skins. The rear spar attachment to the fuselage is made with oversize bolt holes for ease of assembly. All

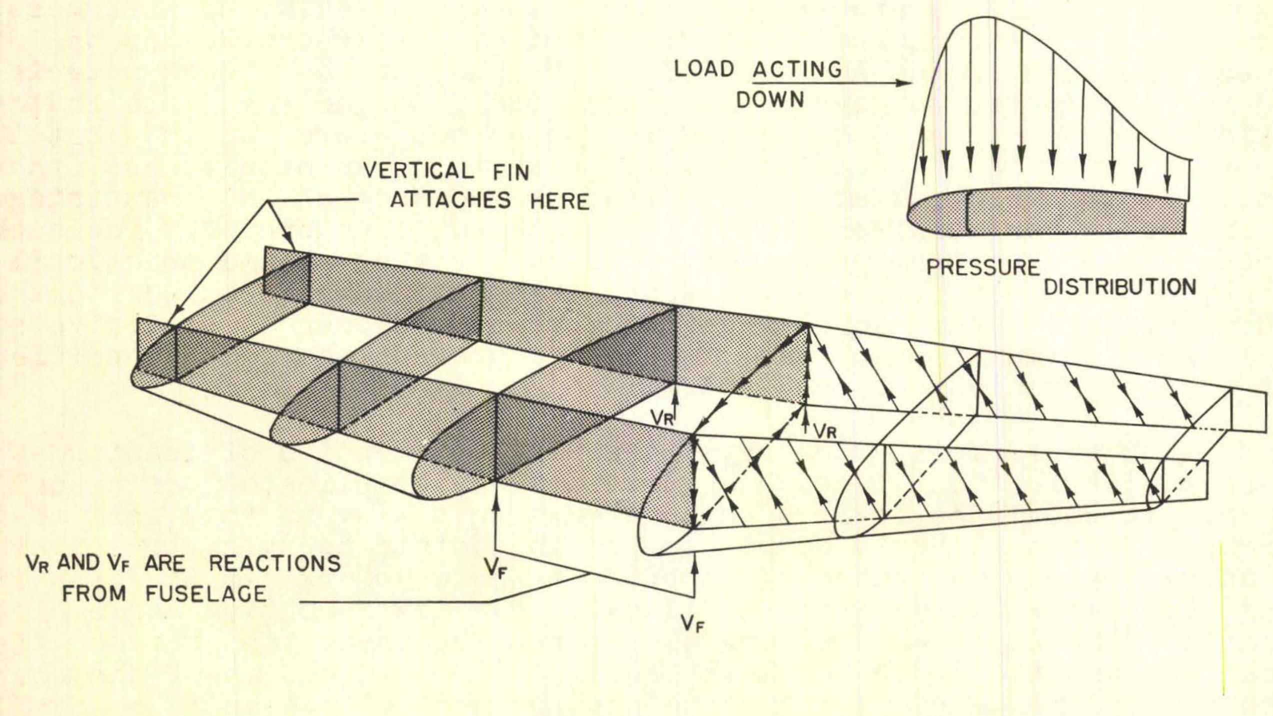


FIG. 10 HORIZONTAL STABILIZER

loads on the vertical tail surface (side loads) are carried into the fuselage through the front spar of the horizontal stabilizer which is attached with ream-fit bolts. It is important that these four (4) bolts AN-7 fit properly at all times. The stabilizer spars are continuous across the fuselage and serve to complete the U-shaped fuselage frames to which they attach. This construction provides considerable rigidity which otherwise could not be realized.

Each elevator, Fig. 11, attaches to the horizontal stabilizer at three hinge points. Vertical loads acting on the elevator are carried by a nose beam to the three attaching points as shown in Figure 11. This nose beam, coupled with the nose skin, forms a box which carries the torque to the elevator horn. At the hinge cutouts in the elevator leading edge, torsional rigidity is maintained by metal boxes formed aft of the spar. The structure aft of the hinge line consists of metal ribs covered with fabric. Air loads are introduced to the structure through the fabric and are carried by the ribs to the nose beam.

The vertical fins mounted at the ends of the horizontal stabilizer spars are of similar construction to the horizontal stabilizers using two main beams and alclad skin covering. The rudders are constructed the same as the elevators, with few exceptions. The major difference is the use of a torque tube across that portion of the rudder nose section where the beam is cut out for the control horn.

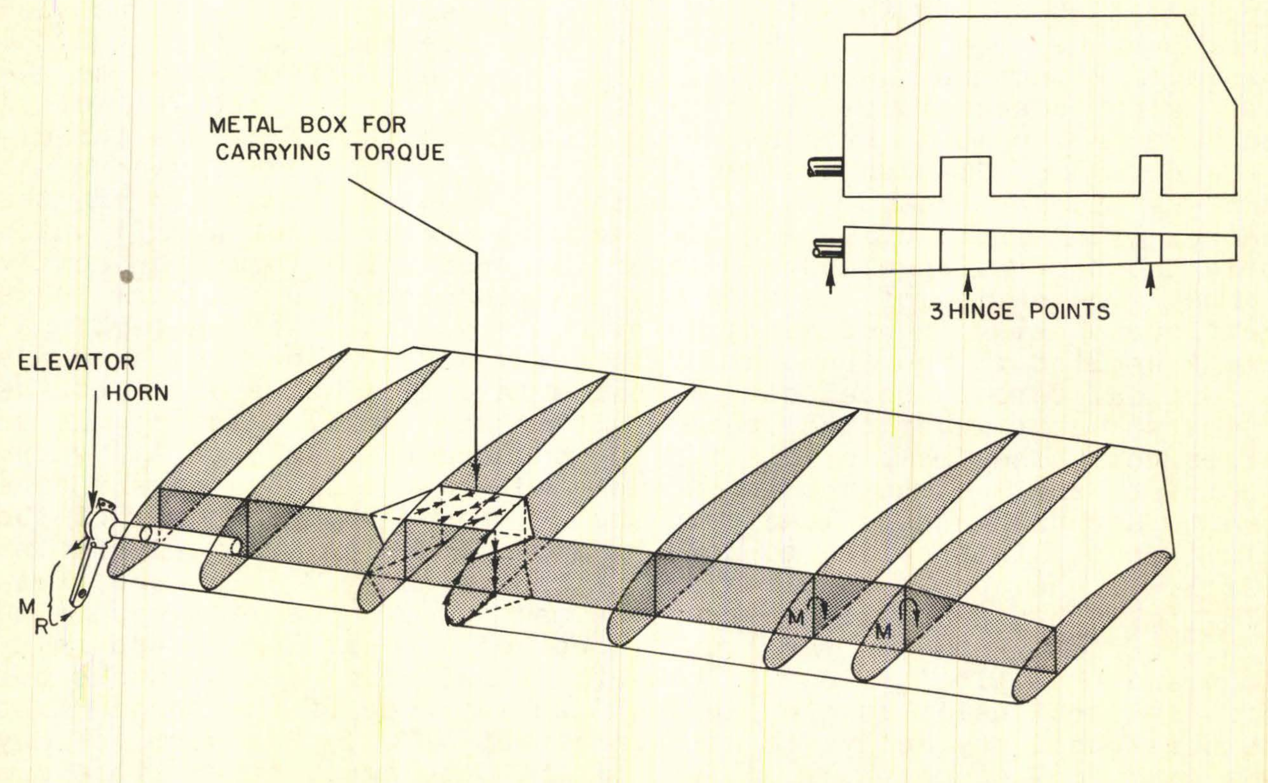


FIG. 11 ELEVATOR

The fuselage of the B-25 Airplane, Fig. 12, is a composite structure of cantilever beams and reinforced shell design. In the remarks that follow, all references to frame locations by number will indicate their distance aft of the extreme nose of the fuselage (the latter being Station zero (0) in the system of notation used). Beginning at the nose of the fuselage and proceeding back as far as Station seventy (70) which is the first full bulkhead, the fuselage structure resembles an open half shell (neglecting the Plexiglas enclosure as structures).

In order to carry the weight of the structure and those items of equipment located between Station zero (0) and seventy (70) for all normal loads, the frames transmit the loads to the side skin, and from there it is carried in shear to the region of the fuselage beyond. The channel lying at the upper edge of the side skin and the lower longeron become flanges of these effective cantilever beams that support the front end. Any side load applied on this portion of the fuselage is carried through the flooring to regions of the fuselage beyond. At Station seventy (70), it will be noticed that there is a relatively large and sturdy frame in the fuselage structure. The purpose of this frame is many fold. In the first place, it serves as a means of transmitting the loads applied to the structure by the nose wheel installation. These loads from the nose wheel are applied at the two trunnions located in the lower portion of the frame. The loads from the trunnions are then carried up through special reinforcements, and carried to the side skin where they are applied as shear to the side skin. Side loads applied to the nose wheel must be reacted at this frame, and the ensuing twist on the fuselage structure, as a whole, must be evenly distributed to the side skins as additional vertical loads. For both vertical forces and torsional moments brought in by this frame, the fuselage structure, forward of Station one hundred fifty-one (151), continues to act as a cantilever beam. This cantilever beam is composed of the channel lying at the pilot's elbow and known as the pilot's rail which forms the upper flange, and the lower longeron which forms the bottom flange. The action of the side skin and longerons, which form these Cantilever Beams in resisting torsion, is as follows: A torsional moment applied to the frame at Station seventy (70) becomes a couple of vertical forces, equal but opposite in direction, applied to the above two cantilever side beams. It is not until this couple of forces reach the frame at Station one hundred fifty-one (151), where a complete shell structure is encountered, that they can revert once more to a running shear load completely around the periphery of the skin. It is interesting to note that in order to properly resist side load, the torque applied at Station seventy (70) is also partially taken by a box-like structure made up of the left-hand side skin, vertical beam on the center line of the airplane passageway floor, and the pilot's floor. This structure forms a continuous box which is torsionally stable, and can resist some of the torque that the nose wheel may apply to Station seventy (70). Furthermore any side load applied to the front end of the fuselage, whether it be due to the airplane banking in flight or from the nose wheel, is carried both by the tunnel and pilot's floor. Thus, it is seen that these

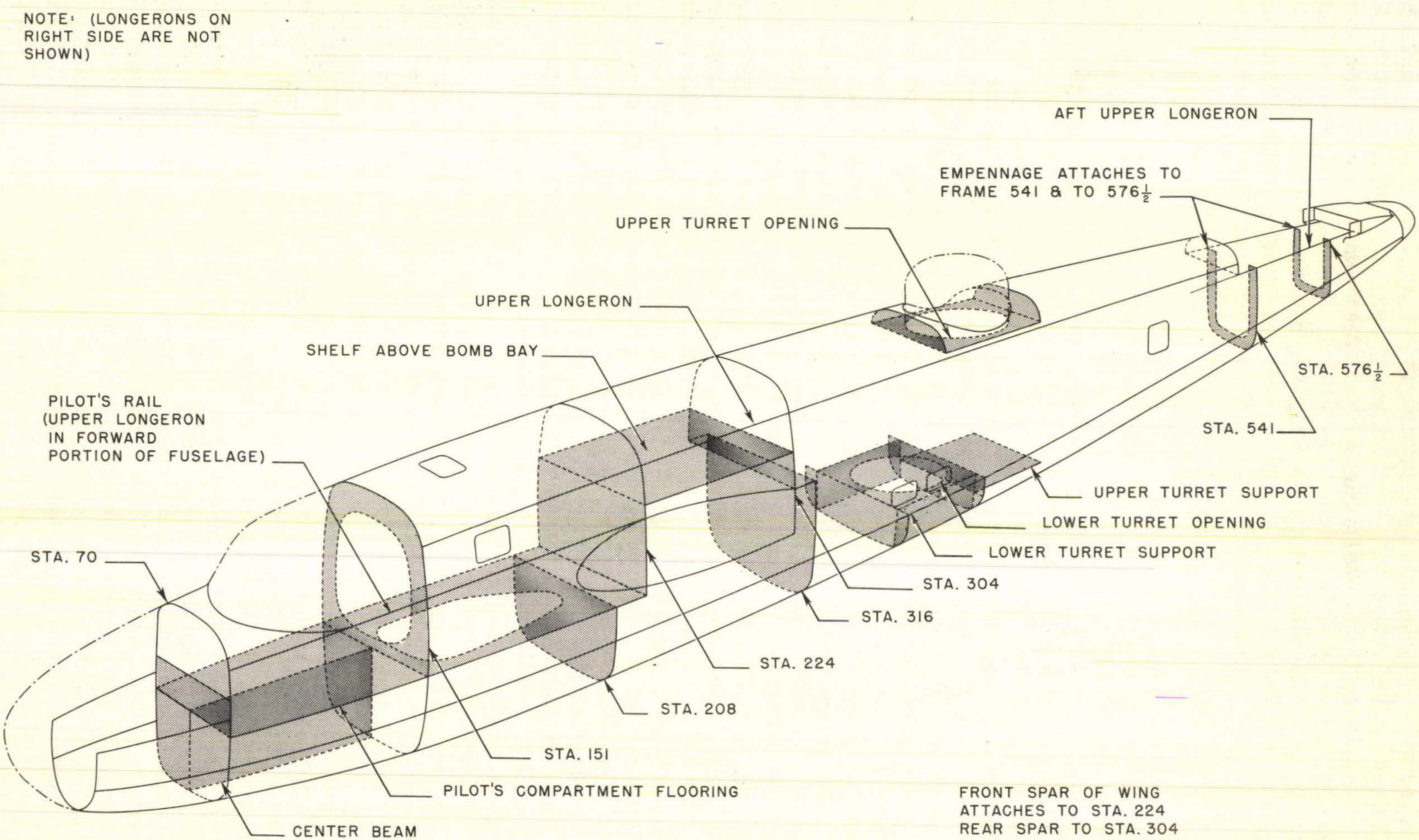


FIG. 12 SHOWING MAJOR FUSELAGE STRUCTURAL ITEMS

two last named items form webs of huge H beams in effect acting between Station seventy (70) and the front spar bulkhead at Station two hundred twenty-four (224). The heavy frame at Station one hundred fifty-one (151), therefore, serves to convert the couple of vertical forces acting on the side cantilever beams to a complete redistribution of shear stress in the entire shell. It also serves in redistributing normal vertical shear loads in the side skin ahead of Station one hundred fifty-one (151), and redistributes these over the entire skin. In so doing, the heavy frame at Station one hundred fifty-one (151) serves as a stabilizer, as it were, to equalize the stresses in the forward and aft shell structure.

It will be noted that immediately aft of Station one hundred fifty-one (151), there are two observation windows, one on each side, and an escape hatch through the ceiling. The skin stresses in the vicinity of these openings are quite high. This is due to the concentration of stresses in the skin where it becomes discontinuous in view of the various openings. From then on the intermediate frames tend to further equalize and redistribute the shear stresses in the side, top and bottom skins. It is also of particular interest to observe that between Station one hundred fifty-one (151), and the front spar bulkhead, there are in effect two (2) upper longerons. The first, which heretofore has been known as the pilot's rail, appears to terminate at the front spar bulkhead. In fact, however, this is not true. There is a connection between the pilot's rail ahead of the front spar bulkhead and the wing to fuselage connecting angle located on the outside of the fuselage. This connection serves as a joint and renders this member continuous, which aft of the front spar bulkhead, takes the form of a wing attaching angle. The connection of the pilot's rail to this finishing angle must not be overlooked. Damage to this joint cannot be permitted when replacing the front end structure during repairs. Elongated holes in this connection are especially dangerous and must be avoided. The principal bending stresses in the shell structure, forward of the front spar, are carried by the upper longerons, pilot's rail and the lower longerons. Hence, it is seen that a heavy connection fitting is used between the upper longerons at the front spar bulkhead (Station two hundred twenty-four). When connecting the front end section of the fuselage to the center section, careful attention should be given to the bolting angle connecting these assemblies. This bolting angle connection also serves to distribute the normal skin stresses caused by bending from one assembly to another, and to further augment the action of the upper longeron fitting at that station. Between the spar frames this portion of the fuselage serves an important function. It is this portion of the fuselage that is compelled to distribute the torsional moments from the wing into the side skins and do so with a minimum of deformation. It also serves to separate balancing couples from the wing in order to equalize the normal shears and moments that exist in the fuselage. It will be noted that at Station two hundred twenty-four (224) and three hundred four (304), only the wing spars pass through the fuselage. As noted earlier in this report, these members alone carry all the wing bending moment in this region, and, therefore, cannot

be drilled into or otherwise reduced in cross section. Also located in this portion of the fuselage are the bomb racks which introduce heavy concentrated loads to the side skins. It should be noted that the bomb racks are attached directly to the fuselage frames in this locality, and thereby, serve as structural members to reinforce the frames. These bomb racks should never be detached from the frames when flying this airplane.

In the upper part of the fuselage, between the spars, there are several heavy arch-shaped frames that have been installed purposely to carry the loads imposed by the loading operations in the bomb bay. Rigidity and strength are both embodied in these two frames and again it is emphasized that no defacing or altering of these frames in any way should be permitted. The shelf of the bomb bay, however, serves as a main structural member. The purpose of this shelf is two-fold. It is a very direct shear path for side loads emanating either in the front end, or in the aft portion of the fuselage and reacted at the wing spars. It also serves to equalize and react the side bending moment applied to the fuselage by the vertical tail surfaces. This side bending moment is for the most part reacted by the wings,and these in turn produce a relatively high shear in the shelf over the bomb bay. Repairs in this portion of the fuselage must be very carefully executed.

After the rear spar bulkhead,Station three hundred four (304), the shell structure is fairly well broken up due to the installation of turrets, side windows, entrance hatch, etc. The aft portion of the fuselage acts as a shell structure for the most part. However, it is pointed out that the longerons and side skin continues to act as huge cantilever beams supported by the center section. The top and bottom skins in general carry any side shear coming mainly from loads on the vertical tail surfaces. Torsion is carried as a running shear load around the periphery of the shell. Around those portions of the aft end skin that are cut away, the frames serve to transmit shear forces from one plane of resistance to another. For example, around the upper turret cut-out, the frames at three hundred seventy-three and five-eighths (373-5/8) and four hundred eighteen (418) transfer the side loads down to another plane made up by the upper turret diaphragm. The latter is forced to act as a framed bent in transmitting side forces forward along the fuselage. The same holds true in the vicinity of the lower turret where the frames transmit side loads to the surrounding floor and thence to the forward portion of the fuselage. The close proximity of windows in the side skin between Station three hundred sixteen (316) and three hundred seventy-three and five-eighths (373-5/8) necessitates a warning when repairing side skins in the vicinity of these holes. It will be noted that at Station three hundred fifty-four (354) a fairly heavy irregular shaped doubler plate is placed under the side skin between the holes. This doubler plate serves a very important function. When repairing this part of the fuselage, it must be replaced with great care.

Throughout the entire shell structure lying between the rear

spar bulkhead and Station four hundred eighteen (418), every frame, every intercostal, every stringer has a definite purpose in transmitting shear forces from discontinuous portions of the skin to the better stabilized sections. Thus, it is seen that any repairs in this portion of the rear end section cannot be executed by simply adding a few additional rivets, an insignificant doubler plate or two, or any other haphazard means of repair.

Going further back to the fuselage between Stations four hundred fifty-eight (458) and four hundred ninety and one-half (490-1/2), it should be remembered that the skin around the window cut-outs is highly stressed at the corners. Any structural repair executed in this section must be such as to replace the original structure or its equivalent. Aft of Station four hundred eighteen (418) to Station five hundred twenty-three (523), this portion of the fuselage acts more normally as a full shell structure. However, for vertical bending (that is due to vertical loads applied to the horizontal tail) the side skin continues to carry the vertical shear with the upper and lower longeron forming the flanges of a pair of cantilever beams. The torsion is carried mainly as a continuous running shear around the periphery of the shell. This same structure continues on to the extreme tail end of the fuselage. It will be noted that the main fuselage upper longeron terminates at Station five hundred twenty-three (523). This is due to the fact that the horizontal stabilizer assembly lies directly beyond. It will be noted that directly under the stabilizer lies another longeron running from Station four hundred ninety and one-half (490-1/2) aft to Station six hundred fifteen (615). The overlap between two (2) upper longerons at Station four hundred ninety and one-half (490-1/2) to five hundred twenty-three (523) is for the purpose of unloading the rear most longeron to the one running the full length of the fuselage. Two (2) sturdy frames located at five hundred forty-one (541) and at five hundred seventy-six and one-half (576-1/2) serve as the main attaching points for the horizontal stabilizer. These two frames plus the longerons support the entire empennage assembly. Aft of Station five hundred forty-one (541), the top skin of the fuselage has been completely removed but in its place the lower surface of the horizontal stabilizer is considered acting. This is made possible by the virtue of the fact that the attachment of the stabilizer to the fuselage completes the fuselage structure and thereby preserves through continuity. The floor of the fuselage, directly under the horizontal stabilizer, while appearing to be a wholly insignificant item, actually receives considerable stress in the event that the tail strikes the ground and the ground reaction is transmitted to the fuselage through the tail bumper.

All in all the fuselage structure represents a composition of various forms of construction so interconnected as to preserve continuity of all essential items. As mentioned before consideration of the large number of cut-outs and the discontinuity of some items in some locations should be realized. Exceedingly great care must be used in making repairs in any part of the structure.

STRUCTURAL REQUIREMENTS OF WORKMANSHIP
PART II

Good workmanship is necessary not only in the original fabrication but especially in the maintenance and repair of a plane. All work must be carefully guided so that the finished product will not only be visually acceptable but particularly be structurally sound. It is hoped that the facts given in this paper will provide an added sense of responsibility so that all defects can be properly corrected under adequate supervision.

It has been found that many erroneous ideas exist concerning the function of structural parts in an airplane. Foremost of these ideas is that the strong appearance of a part indicates that great liberties can be taken in its manufacture. This, however, is not true. The very presence of a heavily reinforced part or piece of structure indicates that it must carry a correspondingly large load, and should be given very careful consideration during its manufacture. Another prevalent misconception is that the appearance of certain parts, such as a rivet, is proper evidence of its being structurally sound. One must remember that a perfectly good rivet head can oft times cover a hole which makes the rivet worthless to the structure. The practice of driving a rivet to cover up a mistake is surely an evil one, and should not exist.

Since the most generally used type of connection between one part and another in aircraft construction is the rivet or bolt, it is of prime importance that the function of this type of connection be well known. Not only does the rivet or bolt itself govern the strength of the connection, but also the nature of the hole through which it passes. All bolt holes should remain within the given tolerances so that proper bearing surface is provided. Also, groups of bolt holes must be consistent so that each bolt will carry its portion of the applied load and make the group act as a unit. Some defects in bolt and rivet holes which cannot be tolerated are:

1. Any circular hole not within the given tolerances.
2. Any elongated hole.
3. Any hole which is not normal to the correct surface.
4. Any hole which is cut countersunk too deep. (The maximum tolerance for flat screw heads is .002 inches below the surface. Rivets must be flush with or above the surface.)
5. Any cut countersunk hole which does not provide bearing surface to the head of the screw or rivet.
6. Any hole which does not present a smooth bearing surface at the shank for the bolt or rivet.
7. Any "stepped" hole.

Let us consider a group of four bolts which of necessity must work together in order for the structure to withstand the loads applied to it. In this group of four bolt holes consider one hole to be oversize as shown in Figure 13. If loads were applied as shown the bolt in the oversize hole could not carry any load until the three remaining bolts had sheared far enough for the fourth bolt to come in contact with the side of the hole. Therefore, three bolts are carrying the load four bolts were supposed to carry.

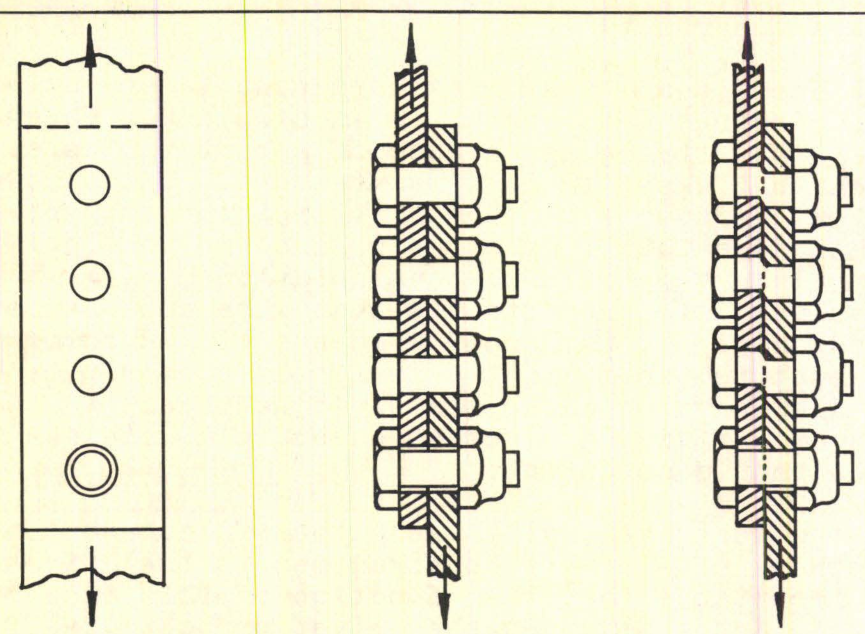


FIG. 13 BOLTED JOINT WITH OVERSIZE HOLE

This shearing action is a definite failure in these bolts and they are no longer capable of carrying their design load. Therefore, the joint is weaker and may fail completely at any time a load is applied. The effects of this type of connection are more rapid wherever the load reverses direction, but in any case, whether the load is applied constantly in one direction, or if it changes direction, a consequent total failure of the joint will occur when the design load is applied. An elongated hole or some other defect can produce the same harmful effects as the preceding example. As can be seen, the foregoing situation does not produce a sound bolted joint. This, and the other type of errors should be avoided in the construction of highly stressed aircraft assemblies. Whenever the subject of elongated or oversize holes is mentioned, one immediately replies that a lot of planes are flying with bad rivet or bolt holes, so what's the difference! There are two obvious answers to this statement: One is that the particular rivet or bolt fortunately does not carry a high load and the other is that the plane has not been flown in its critical design condition. Which bolts and rivets carry a high load cannot be answered in general terms, since even such parts as pilot's compartment flooring and hand hole covers actually carry loads due to flight conditions and form a very important link in the airplane's primary structure. Each individual case

of defective rivet or bolt holes should be referred to the proper authorities for adjustment.

A common reaction to a mislocated or otherwise defective hole is to plug the hole and re-drill it in its proper location. This, however, is not sound reasoning from a structural standpoint. For example, consider Figure 14, as shown in the case where the plug has been added and then almost entirely removed by re-drilling the hole,

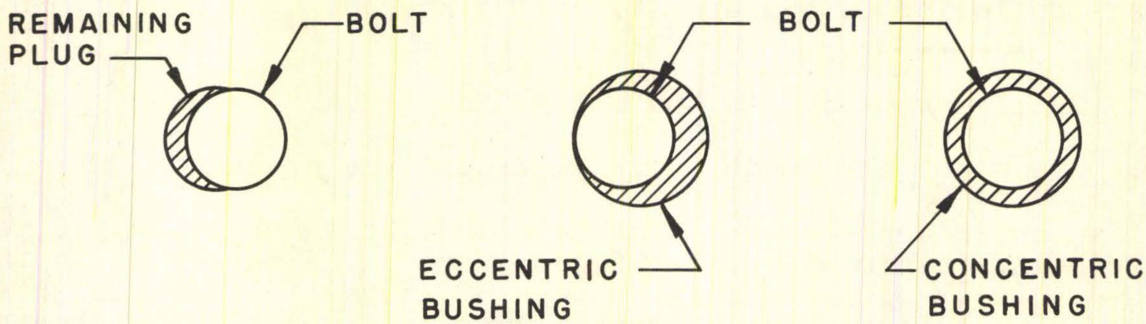


FIG. 14 EXAMPLES OF PLUGGING BOLT HOLES

one can see that the remaining portion of the plug could drop out of its place. Further, if the plug were to remain in place, the load on the bolt or rivet would not be evenly distributed over the surrounding material. One has no way of predicting the exact action of an installation of this sort. Consider the second example where the new hole does not cut away so much of the plug but is eccentric with the outside periphery of the plug.

If a load were applied to the bolt it would not be reacted directly below the bolt but would be reacted at a point somewhere to the side of the bolt. This action would introduce twisting forces on the plug and give it a tendency to turn. This produces an expanding force in the large hole,and the surrounding material is subjected to an unknown stress. Similar to the first case, this plug can become loose and turn in the hole so that the bolt hole might be covered by a part which attaches over it. The third example shows a properly installed bushing which could be used wherever conditions permit. The two major considerations are the amount of net edge distance available where the hole is close to the edge of the part, and also the amount of net tension area that remains after the enlarged hole is drilled. If a bolt carries a tension load, consideration must be given to the amount of original material left under the head of the bolt or nut.

Bushings in all cases should be pressed fit and so designed that they remain in place throughout the life of the part, and should be made of the same material as the original part or of some stronger material.

The ever present difficulty of cracks in sheet metal is especially prevalent in the manufacture of aircraft. Generally, cracks occur at points of cold working, such as sharp bends; and cracks also appear when rivet or bolt holes are drilled or when the sheet is being dimpled for flush type rivets or bolts. Many times these cannot be avoided. Therefore, everyone should constantly be on the alert to report any crack which may appear. In all cases, cracks and other defects should be cited to the person in charge so that proper action can be taken to prevent its growth or to reinforce the part where necessary.

The following steps are taken to prevent the growth of a crack:

1. Drill a #50 hole at the end of the crack.

2. Clean out any rough material around the crack.

If a crack appears around a dimpled hole or at any other strategic point a proper repair will be made. The material in the immediate vicinity of a crack is always of a questionable character and should be reinforced under proper supervision. If the material is inferior, it must not be used.

Many parts become scratched or dented in the course of fabrication as well as in service. This is especially true of tubing. The importance of a smooth surface, free of defects, cannot be overemphasized and is of such magnitude that the following explanation of "Stress Concentration" and "Stress Flow" is included.

Consider the piece of material in Figure 15, sketch (a), which is continuous. The forces at one end pull on particles of material which in turn pull on the adjacent particles, which action transmits

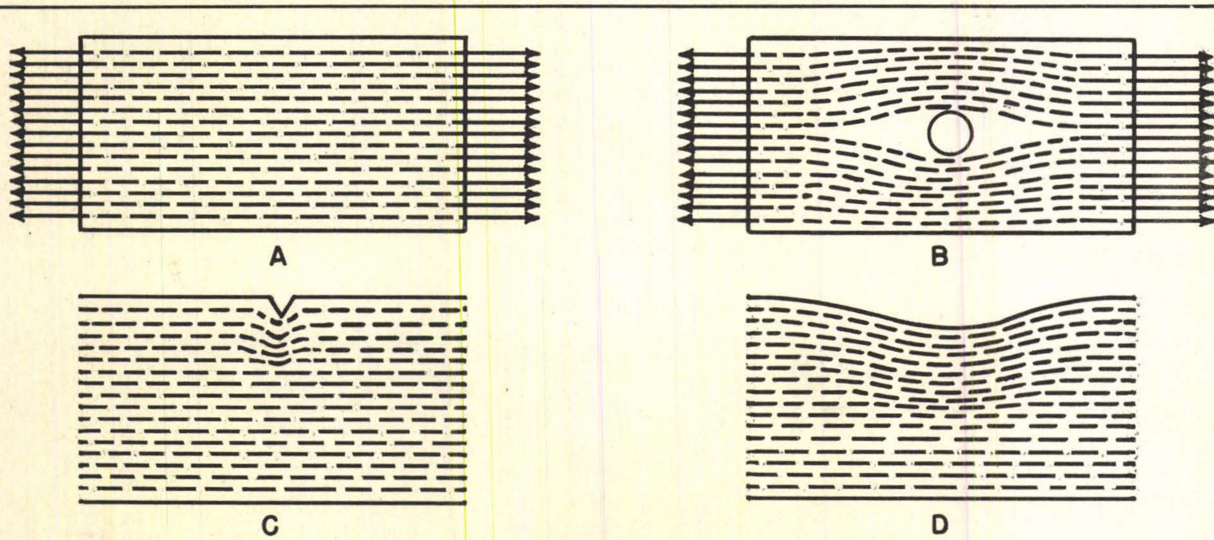


FIG. 15 STRESS CONCENTRATION AND FLOW IN MATERIALS

the force from one end of the part to the other, where an external reaction picks up the load.

The dotted lines represent this action and are called "Stress Flow" lines. Now compare these straight lines with those in the adjacent part (b) through which a bolt hole has been drilled. The lines in this part must detour around the hole and become concentrated across Section A-A. Also, in the third item (c), which contains a sharp indentation similar to a scratch, the "Stress Flow" lines are piled up near the defect. The latter two cases are examples of "Stress Concentration". One is considered in the original design of the part and is a known quantity, but the other is characteristic of a faulty part, was not considered, and is an unknown. The extreme "Stress Concentration" in item (c) can be alleviated by burnishing the material as shown in Part (d) of the sketch. The art of burnishing has been propagated to inexperienced personnel with the idea that the appearance of the part is of basic importance. This method of removing scratches or similar defects has a very important structural phenomenon behind it. Study for a moment parts (c) and (d) of the foregoing sketch. A scratch with a sharp angle has been made in the surface of the part. As shown in Part (c), stress concentrations appear around the sharp corner. When, however, the surrounding material is removed and the surface is made relatively smooth as in part (d) the change of "Stress Flow" is more gradual and the high concentration of stresses disappears. This is a physical phenomenon which must be accepted and kept in mind whenever one gives consideration to a part which is scratched. The sharp indentation is especially serious when the part is subject to vibration.

The exact appearance of a stress concentration area is not to be defined merely as a scratch, since such things as inadequate fillets, file marks, coarse machine tool marks, and inspection stamps often cause serious stress concentrations which result in progressive cracks and ultimate failure of the part. Many studies have been made concerning the prevention of the failure of metals. One book (Battelle Memorial Institute - "Prevention of the Failure of Metals under Repeated Stress" - 1941) presents as an example the failure of a propeller blade. The patent date had been stamped into the material causing high stress concentrations which resulted in a failure of the blade and a serious crash.

These items are especially important to the aircraft industry because the working stresses are usually so high that any irregularity of any kind may produce stresses above the strength of the part.

The efficient type of plane built today requires good workmanship. It is hoped that the information set forth in this paper will serve to answer some of the many recurrent questions which are brought up daily in the shop, and will aid in providing the better type of craftsmanship necessary in our modern planes.

REPAIR OF STRUCTURAL PARTS
PART III

The following pages include suggestions of a general nature which are intended to broaden the possibilities for making repairs rather than to confine them to a definite set of rules. Adequate repair of aircraft parts, especially in the field, requires ingenuity, experience, and good judgment. The seriousness of executing repairs properly cannot be overemphasized, and everyone charged with this duty should conscientiously endeavor to carry out his work as accurately as possible.

One of the commonest repairs is one affecting the covering of a plane. In making a repair on the skin of an all metal airplane, the attachment of a section of skin will govern the repair made on it. To illustrate this, consider a wing panel as shown in Fig. 16.

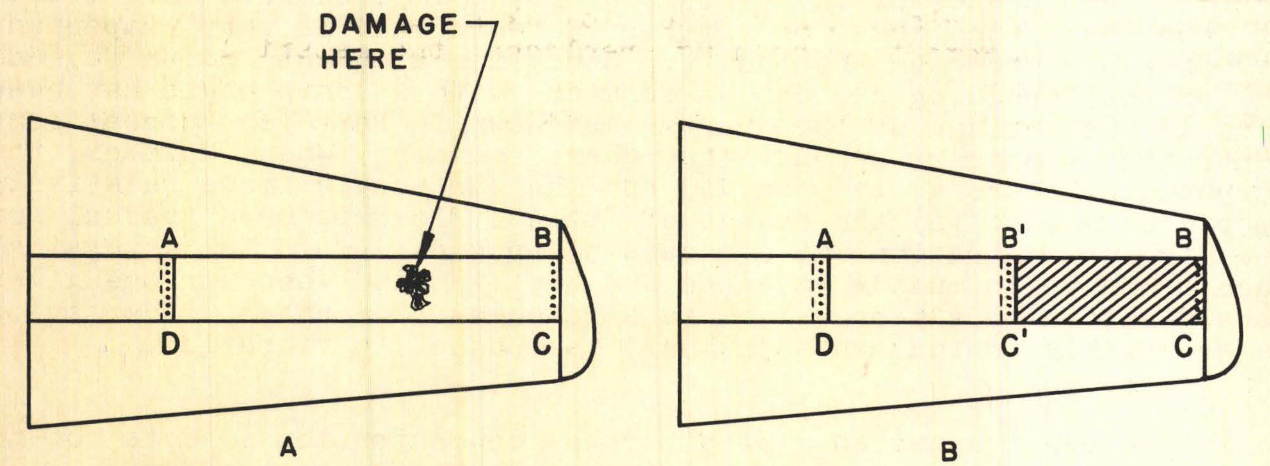


FIG. 16 SKIN REPAIRS

Part (a) of Figure 16 shows that a portion of the skin ABCD has been damaged and it has been found necessary to cut the skin and replace the damaged section. The cut and splice should be located midway between two ribs, to prevent interference with rib rivets and to provide sufficient space for the splice. The number and size of rivets for the splice can be determined by investigating the original splices at AD and BC. The inboard joint will usually be the stronger of the two. If this joint consists of a single row of AD5 rivets three-fourths (3/4) inches O.C., the new splice B'C' will be satisfactory if the same joint is employed, i.e., one row of AD5 rivets and three-fourths (3/4) inch O.C. The theorem follows that if a

splice is made equal in strength to the strongest connection parallel to it on the subject sheet, that splice will be of adequate strength. Ordinarily, the connection most inboard on the wing and closest to the wing connecting points on the fuselage will be the strongest, since the loads usually increase in these directions.

Two types of joints can be employed, the butt splice and the lap splice. The butt splice requires an extra part and twice as many rivets as the lap splice, but produces a smooth joint wherever aerodynamic cleanness or installation problems require it.

In making a repair of any part for some slight damage such as a crack or a cut, a good thought to keep in mind is that the damage must be "bridged". That is to say, one side of the damaged part must be connected to the other side in such a way as to re-establish the original strength of the piece. This thought suggests the basic idea that any damaged portion of material must be replaced. A doubler, when properly installed, can be considered a replacement for cracked material; a new piece of skin spliced into place is surely a replacement; a bushing replaces the material taken away when an oversize or otherwise defective hole is drilled; these are concrete cases of "Bridging" the damage to restore the use of a faulty part.

Station

Most rearward C. G. - 252

Most foreward C. G. 236

Surface Controls - Read particularly P 1-2 7 - 10 - 15 16 - 25

Check degree of movement of controls etc. & trim tab wheels. (location)

Bungee checks

Locks for rudder, aileron etc.